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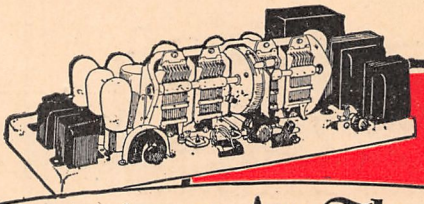

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TONE Fidelity . . . the master salesman of radio . . . is the constant companion of the Thordarson equipped receiver. A snap of the switch . . . a turn of the dial . . . and his message begins. He collects no commissions . . . has no expense account, yet works unceasingly, delivering his message of quality reproduction to everyone within earshot. Without his effortless activity the set manufacturer's days are numbered, for the public will accept no substitute for Tone Fidelity.

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Over $600,000,000 is being spent yearly for sets, supplies, service. You can get your share of this business and, at the same time, fit yourself for the big-pay opportunities in Radio by joining the Association.

Join the Radio Association of America

A membership in the Association offers you the easiest way into Radio. It will enable you to earn $3.00 an hour upwards in your spare time—train you to install, repair and build all kinds of sets—start you in business without capital or finance an invention—train you for the $3,000 to $10,000 big-pay radio positions—help secure a better position at bigger pay for you.

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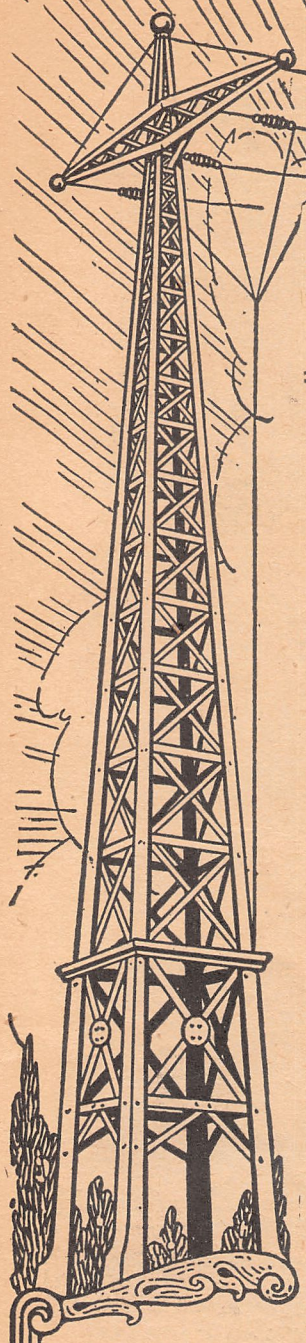

RADIO NEWS

Volume 10 May, 1929 Number 11

ARTHUR H. LYNCH, Editor-in-Chief
C. P. MASON, Associate Editor JOHN B. BRENNAN, Jr., Laboratory Director
C. WALTER PALMER, Director Information Service

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IN THE FORTHCOMING ISSUES

For our June and following issues RADIO NEWS has in preparation, among others, the following articles of interest to our constructors:

A NEW BROWNING CIRCUIT. Professor Glenn H. Browning, co-inventor of the famous Browning-Drake, has developed a new receiver employing the new UY-224 A.C. screen-grid tubes. On a trial of this set in Boston, nine Pacific Coast stations were received on the loud speaker. It is designed to work with the new Millen "Velvetone" amplifier. A series of exclusive articles, covering the mathematics, design and construction of this remarkable set will appear in the next few issues.

THE "VELVETONE" 245-TYPE AMPLIFIER, the first to use the new UY-245 A.C. 2½-volt power tube, designed by James Millen, will appear in June. It gives remarkable volume and quality with a 245 push-pull stage, and furnishes also "A-B-C" power for a receiver.

THE "EVERYMAN A.C. SCREEN-GRID FIVE," by Zeh Bouck, will be so described that it may be readily constructed either as a complete receiver or as a tuning unit to operate a separate power amplifier.

A NEW TYPE OF SUPERHETERODYNE. This receiver, the last achievement of the late R. E. Lacault, inventor of the Ultradyne, will appear in the near future, and be found of special interest.

A MODERN SINGLE-CONTROL SCREEN-GRID RECEIVER. John B. Brennan, Jr., formerly Technical Editor of "Radio Broadcast," will describe another very interesting receiver especially adapted to present-day requirements in home entertainers.

SHORT-WAVE TRANSMITTERS. At the request of many readers, RADIO NEWS will resume publishing articles on this subject, beginning with a low-powered (201A) outfit to give the amateur a modest start at low cost.

AVIATION RADIO EQUIPMENT. The remarkable recent developments of apparatus of this type will be exploited in the next few issues of RADIO NEWS; the improved Radio Beacon, one of the most important adjuncts of commercial flying, will be described in the June issue.

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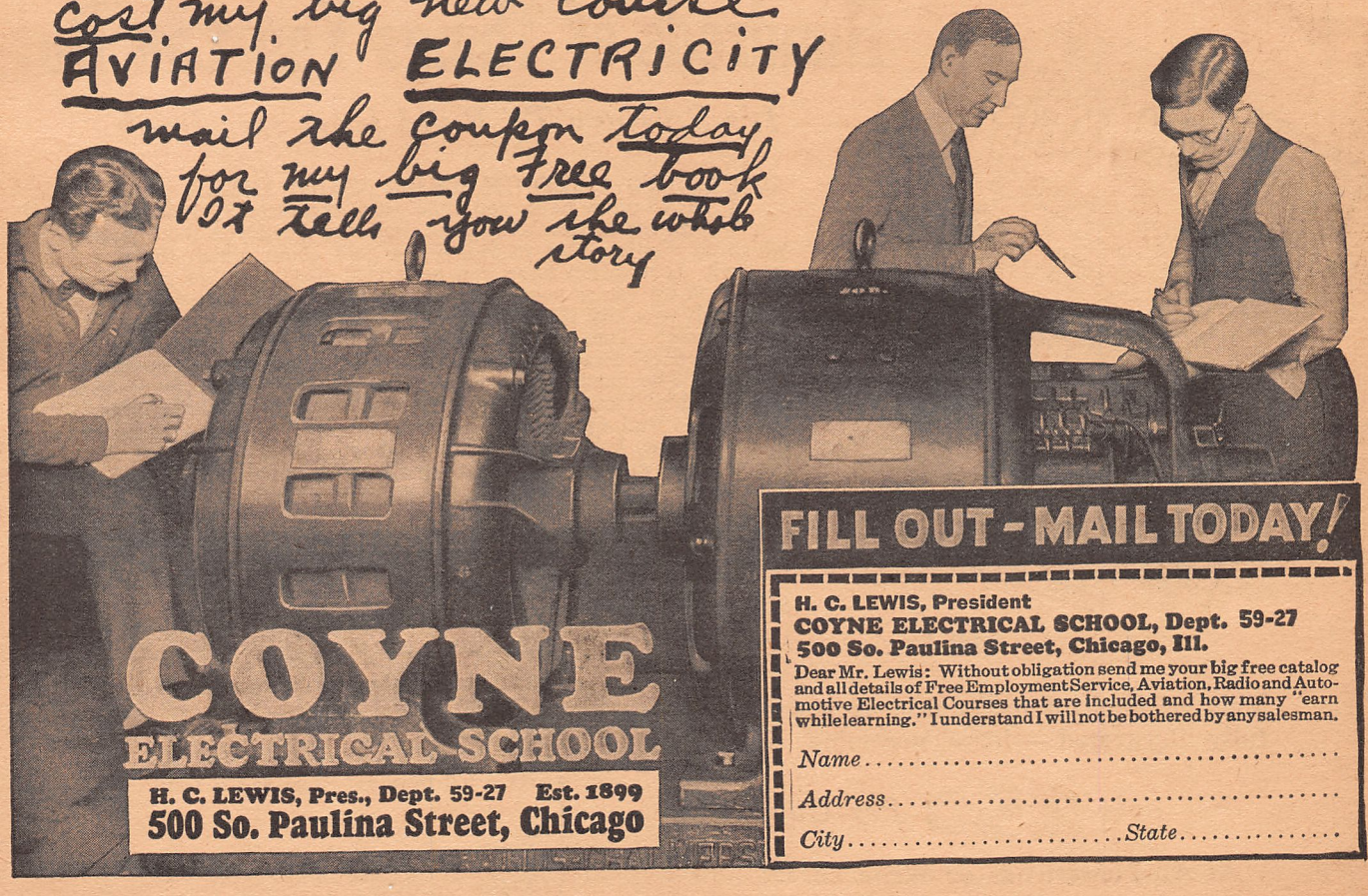

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"Thar's gold in them thar hills, Pardner," and there is a wealth of information in this well-illustrated book.

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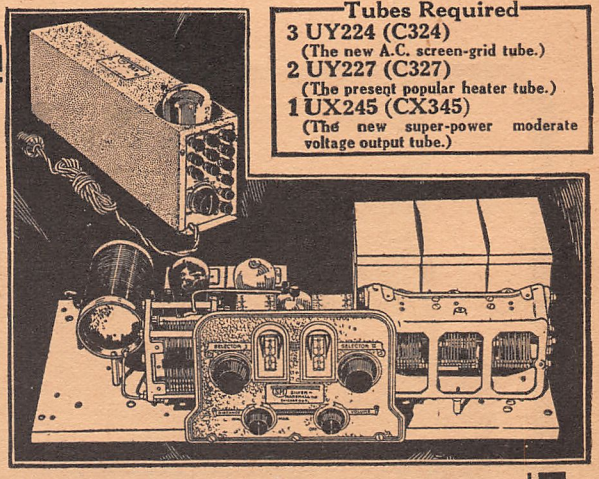
1930 Reception Will be Different!

Try It NOW and See—in the New

S-M 720AC All-Electric Screen-Grid Six



Tubes Required
3 UY224 (C324)
(The new A.C. screen-grid tube.)
2 UY227 (C327)
(The present popular heater tube.)
1 UX245 (CX345)
(The new super-power moderate voltage output tube.)

Know How Next Year's Best Will Sound

A SCREEN-GRID tube with A. C. heater-type filament, *nearly twice as good* as the wonderful UX222—and the '22 in S-M 1929 sets is enabling S-M setbuilders to get station after station never heard with common factory-built sets. . . A power tube with more than sufficient undistorted output capacity to fill the best dynamic speaker—yet *without* the high plate voltage required for the 250. . . Every refinement of precision manufacture as built into the tremendously successful 720 (D.C.) Screen-Grid Six—plus improvements which make the new 720AC All-Electric a set capable of far better reception, both as to distance range and selectivity, and tone quality as well, than even the original, never-yet-equalled, 720. . . Be the first on the ground with it! Get your order in at once to your S-M jobber or dealer.

Used with the new S-M 669 power supply, the 720AC is a complete all-electric receiver designed especially to bring out the extreme possibilities of these new tubes. Price, completely WIRED in 700 two-tone shielding cabinet, less tubes and power unit, $117.00. Component parts total $78.50; cabinet $9.25 additional. S-M 669 Power Unit, WIRED, $57.50.

S-M 720 receivers can be changed over at slight cost to the 720AC circuit.

S-M Audios-Positively Guaranteed Superior

That same unchangeable purity and fidelity of tone, which has established S-M supremacy even more firmly this year than ever before, can be built into any receiver or amplifier by using the new S-M Clough-system audio transformers. Guaranteed absolutely and unconditionally to surpass, in their uniform amplification of all notes from 5000 down to 40 cycles, any other transformers obtainable on the American market at any price, these unique instruments make use of a principle totally different from anything used in standard transformer construction—built-in resonance to even out the amplification curve in the critical range which ordinary transformers weaken—and a circuit which keeps D.C. plate current entirely out of the transformer winding and thereby avoids the common injurious effect of hysteretic distortion. Amplification obtainable—running as high as 4½ to 1—is far higher than with any standard transformers of comparable tone quality.

S-M Clough system audios are now obtainable in a complete line, for both single and push-pull amplification, as follows:

255 and 256, for standard use in first and second stage respectively. Each....$6

225 and 226, similar to 255 and 256, but larger and slightly more perfect in both frequency characteristic and amplification ratio. Each.....$9

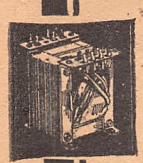
257 Push-Pull Input Transformer, to operate from one amplifier tube into two 171A, 210, or 250 tubes. Each..$7

227 Push-Pull Interstage Transformer, to feed from two 112A, 226, or 227 tubes into two 112A, 226, 227 or 171A, 210 or 250 tubes. Each.....$8

258 Tapped Output Impedance, to feed from two 171A tubes into any standard speakers. Each.....$5

248 Universal Output Choke to feed out of two 210 or 250 tubes into one to six or more standard speakers; provided with several impedance-matching taps. It will handle over 20 watts without core saturation. Open-mounted. Each $7

228 (248 in case like 227). Each.....$8



For the New Tubes: S-M 335 Power Transformer

This is the transformer used in the new S-M 669 power unit. It contains one 105 to 120 volt primary; one 5 volt, 2 ampere, rectifier filament winding; two 2.5 volt, 6 ampere, filament windings. Plate voltage with one '80 tube, 300 volts at 100 m.a. Provided with iron end terminal mountings, or (335U) in open mounting; either type $15.00.

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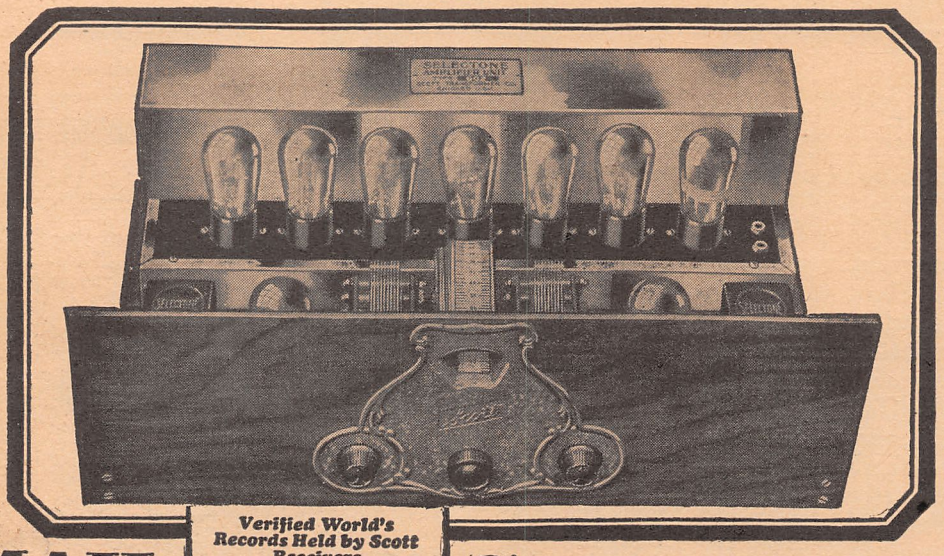

Verified World's Records Held by Scott Receivers

(1) A world's record for number of stations heard, distance 6,000 to 8,000 miles.
6 stations distance 6,000 miles.
7 stations distance 7,000 miles.
6 stations distance 8,000 miles.
(2) A world's record for greatest number of programs heard from stations distant 6,000 or more miles.
19 programs 8,000 or more mls.
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THIS is the New Scott World's Record A.C. Nine with the Single Dial Control. The intermediate amplifier is completely shielded. The appearance of the receiver is that of the fine precision instrument which it is.

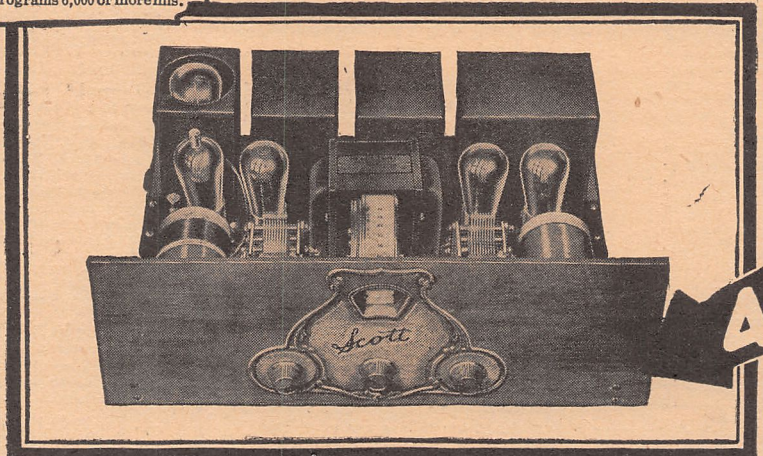
ONE DIAL *Control on the New* Scott A.C. Nine

The New Scott World's Record A.C. Nine which again repeats its unanswered challenge to the whole world of radio to equal its performance in any kind of competitive test, is now improved by the embodiment of *Single Dial Control.* Now, by merely plugging into your light socket and turning one small knob, practically any station within 10 kilocycles of any other station is brought in with thunderous volume and with vigorous, life-like, full-rounded tone. Anyone can tune the Scott World's Record A.C. Nine *now.* Anyone can fully enjoy its oft-demonstrated limitless range and revel in the endless parade of distant stations its brightly illuminated drum dial records. Thoroughly shielded—perfectly stable—no hum—using A.C. tubes—stations come in at only one point on the dial and always at the same point.

Truly, in all its history, radio has never offered so much as is available to you in this latest model of the one *proven* World's Greatest Receiver.

The *New* Scott Symphony MODEL A.C. or D.C.

To meet the demand for a better performing custom built small receiver which is low in price but high in performance,



The NEW 4 TUBE MODEL

the new Scott Symphony was created. One stage of Shield-Grid Amplification is used, making it the equal to many nine tube sets and is surpassed in general performance only by the new Scott World's Record A.C. Nine. One dial control—easily tunes out the locals and brings in distant stations. Engineered to the same quality standard as the nine tube model and backed with the same unqualified guarantee of superior performance and complete satisfaction.

Self-contained power supply in A.C. Model

The A.C. Model of the Scott Symphony is equipped with built in A.C. power supply which supplies filament, plate and grid current to all A.C. tubes used and the 171 A power tube. The D.C. Model is so designed electrically, that its current consumption is extremely low, thereby making it the ideal receiver for sections where A.C. current is NOT available or where it is desired to use batteries.

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Scott Apparatus Now Sold Only thru CUSTOM SET BUILDERS

The custom building of fine radio receivers is *still* a profitable profession with our plan for those who are technically qualified, because there are thousands of people who want the best there is in radio and who know that the best cannot be produced by mass production methods but only thru the custom method of hand building.

This season Scott Products will not be sold direct to consumers nor thru jobbers, but exclusively thru professional custom set builders. We have adopted this policy because we believe in you and recognize the fact that your ability to deliver a far better receiver than any mass-production factory can make, and our protection of your market, will result in the growth of your business, and in turn, the growth of ours. Our line this season is complete and will enable you to supply a Scott receiver in a good console from as low as $90.00 to as high as $1,500. It embraces the Scott World's Record Shield Grid Nine, the Scott World's Record A.C. Nine, the Scott Symphony in both A.C. and D.C. models, and a line of cabinets which enable you to out-class, at the right price, anything else in the field.

We Help You Promote Sales

We have, ready to imprint your name thereon, illustrated advertising mailing pieces for you to use in spreading the news of your appointment as the franchised Scott Builder in your locality. Our 48 page book "How to Sell Good Custom Built Radio" tells you all about the Scott Plan and our proposition. It is the first and only complete, practical treatise ever prepared which clearly points the way to financial success for the Custom Set Builder. It is, however, sent only to those who can qualify and meet our standards as a Custom Set Builder.

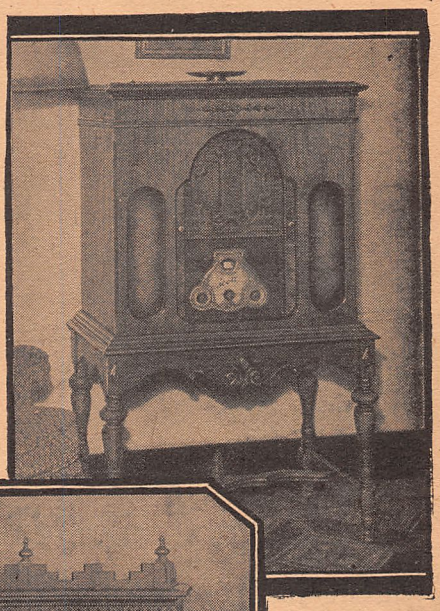
MAIL COUPON

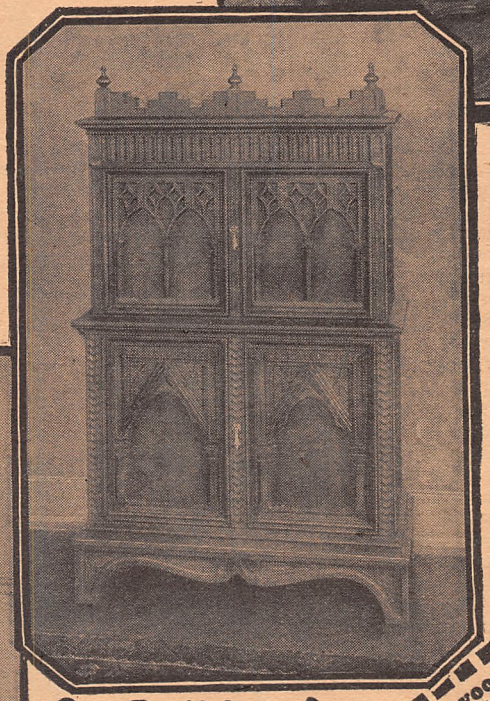
For Qualification Blank

The Scott Franchise is, most naturally, a valuable one. Not only because of the obvious superiority of Scott Receivers, but because after you are appointed a Scott Franchised Builder, you will have taken a step towards establishing for yourself a REAL PROFITABLE business that will, with our co-operation and assistance, enable you to make more money than you ever dreamed was possible in the Custom Set building business.

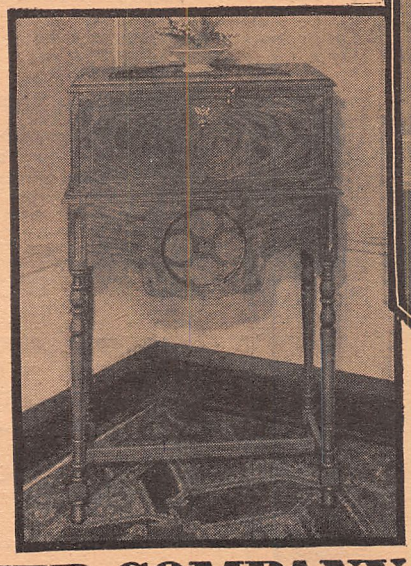
Complete Line of CABINETS

Never before have we had a more beautiful or complete line of cabinets. They are the last word in "moderness" with sliding doors, rich selected walnut burls, hand rubbed finish. We show on these pages three of our ten different models and all are fine examples of the modern furniture craftsman's art. They will enable you to meet every cabinet demand from the most modest to the massive, rich, dignified hand carved console that will add distinction to the finest home. You can secure four of these consoles either with or without phono combinations. All are of the very highest quality and workmanship but are priced unbelievably low.





ABOVE: *The Taranaki*
TO THE LEFT: *The Canterbury*
BELOW: *The Milford*



TRANSFORMER COMPANY
4450 Ravenswood Avenue ▲ CHICAGO, ILLINOIS

Set Builders! **MAIL THIS COUPON**

Scott Transformer Co., 4450 Ravenswood Ave., Chicago
Send me details of your new models and Professional Set Builder's Qualification Blank and your proposition. I understand that your 48 page book "How to Sell Good Custom Built Radio" will be mailed me after I qualify. Exp.-C5

Name.....
Street.....
City.....
State.....

Mammy Goes Home by Radio!

Steps right out thru powerful local Chicago stations,--and finds Birmingham, Alabama *with* New Radio Invention

"I Sho' was Happy!," says Mammy Jo

MAMMY JO was waiting up for us—her eyes rolling with excitement. She had been lonesome all day, she said. Even with her two small charges, and the radio for company, she was blue—just pining for a voice from home. We knew she used to try, time and again, to pick up broadcasts from Southern Stations, but without any success. However, that was not surprising; strong local stations had always smothered out distant ones on my radio.

"I think that Radio's gone crazy," now cried Mammy joyfully. "I just thought I'd find me some peppiah music to cheah me up, so I starts foolin' with the dials. Nex thing I knows, the announcah man says I's listenin' to Station WAPI, at Bummin'ham, Alabama—and thah I was, down in my Own Home Town! I listens to that station fo' a long time, and I sho' was happy. Dey ain't got music like dat up heah. No SUH! I sho' does think dat thing has gone crazy."

Subwave-Aerial Recommended by Licensed Radio Operator

"After thoroughly testing your Underground Antenna I find that it gives entirely satisfactory results. I would recommend it in place of inside aerials, roof aerials or loop aerials, for reasons of clearer reception, reduced pick-up of outside interference and static, easy and convenient installation and it is non-directional."

Yours truly,

Wm. Stringfellow.

(Reprinted by permission of Mr. Stringfellow)

Ground Wave Reception

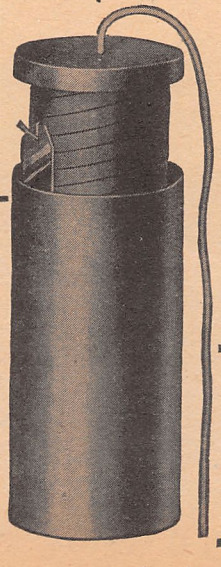
"No it hasn't Mammy," I laughed. "You've just been getting Ground Wave Reception with my new antenna, Subwave-Aerial. Until yesterday, I had my antenna up on the roof. That's why air noises and all the big powerful broadcasting stations we have around here in Chicago kept out-of-town stations away. Don't you remember, Mammy, you asked me yesterday why I was digging a hole in the ground under this window—and I told you I was digging up a new radio?"

"Yes Suh," grinned Mammy. "But does you all mean to say dat aerial business got me my home town?"

"That's right Mammy," I assured her. "You know it's the aerial that picks up radio waves and brings them to the set. When the aerial is in the ground, it's protected from a lot of interference. From now on you can probably go back to Alabama every night."

Reduces Static—Gets Clearer, Sweeter Tone

That was explanation enough for Mammy Jo. But when I told my friends about my amazing new underground aerial—how it reduces noise, gets clearer reception on both near and far stations, better selectivity too, and much finer tone—and that it didn't cost me a cent more than an ordinary aerial—and is guaranteed for 25 years—every one of them wanted to know all about it and try out a Subwave-Aerial.



YOU can test Subwave-Aerial FREE

When Subwave-Aerial can get results such as illustrated by the story above why let noise and interference keep you from getting distance on your radio?

Now you are given the opportunity to try out this wonderful new radio development without risking a cent. There's a new radio thrill in store for you! We feel confident that when you've heard the amazing difference in reception, and realize the great convenience of this modern combined antenna and ground, you'll wonder how you ever put up with the old, inefficient, dangerous method. Hurry and send for all the interesting details about Subwave-Aerial! Mail the coupon Today!

UNDERGROUND AERIAL PRODUCTS
Suite 618, St. Clair Building, Dept. 827-G.W.
St. Clair and Erie Streets Chicago, Ill.

UNDERGROUND AERIAL PRODUCTS,
Suite 618, St. Clair Bldg., Dept. 827-G.W.,
St. Clair and Erie Streets, Chicago, Ill.

Rush illustrated literature on the new Subwave-Aerial and details of your Free Test Offer. No obligation to me.

Name .....

Address .....

City..... State.....

Radio News

Editorial and General Offices, 230 Fifth Avenue, New York

Vol. 10 MAY, 1929 No. 11

Radio and Aviation

AVIATION in this country is progressing with the same giant strides taken by the radio industry during the past few years. The development of air navigation and safety to life in the air will, to a large extent, depend upon engineering achievement in the radio field as applied to aviation. It is interesting to recall, in passing, that radio and aviation have been companion sciences from their earliest days. Prof. Reginald A. Fessenden, one of the most prolific inventors this country has produced, conducted much of his preliminary work on radio on Roanoke Island, just about three miles from where the Wright brothers were doing their first work with gliders at Kitty Hawk, at the same time.

The very great need for suitable radio safeguards for flying has been brought very thoroughly to the public mind by almost every long-distance flight. The lack of suitable radio equipment made it necessary for the late Commander Rogers and his crew of the Navy flying boat to spend six horrible days adrift in the Pacific. Similar occurrences have been frequent, and their number is increasing. On the other hand, it has been possible for an airplane flying from California to Australia to be in almost constant communication, either directly or through relays accomplished by steamships, with both the American and Australian continents. Even Lindbergh, in his flight, would have saved an interested, hopeful, but nevertheless fearful world much anguish if his progress across the Atlantic could have been followed by radio.

Flying the night mail has been made very much safer by radio beacons and other important radio developments. Commercial aviation may be benefited in much the same fashion; and it is very likely that within the next year or two the arrival and departure of airplanes at the various airports throughout the world will be greatly facilitated by the work radio engineers will undoubtedly do in that time. Commercial enterprises using the airplane for the transportation of their merchandise will be enabled to keep in touch with their own carriers at will.

This rapidly-growing field of enterprise is one which should intrigue the interest of every forward-looking radio engineer. We believe that a great many of the men who have contributed greatly to the science of radio are interested in aviation, and with this idea in mind we contemplate including in Radio News and Science and Invention—two of the scientific publications in the Experimenter group—sections devoted to flying.

There is at present, a very rapidly-growing interest in the motorless machines called gliders. (Most of the preliminary work done by the Wright brothers was done with gliders.) People who are devoting their attention to the development of the air industry throughout the world are very keenly interested in the glider from the standpoints of study, pleasure and profit.

We have been very fortunate in securing as contributing editor for aviation, to both of our publications, Mr. Augustus Post, who was for twenty years Secretary of the Aero Club of America, and who, as far back as 1914, made the following prophecy of Lindbergh's flight to Paris:

"A man is now living," he wrote, "who will be the first human being to cross the Atlantic Ocean through the air. He will cross while he is still a young man. All at once Europe will move two days nearer; instead of five days away, it will be distant only thirty hours. . . . It would seem out of keeping with the general economy of weight, when even the parts are not duplicated, that the pilot should be carried in duplicate. . . . As for keeping awake and alert for the whole time of flight, every aeronaut knows that this is possible. . . . Whoever crosses the ocean through the air for the first time will be too busy to be lonesome!

"Imagine, then, the welcome that awaits the Columbus of the Air! The cables warn of his departure, before him flies the wireless announcing his progress. Ship after ship, waiting the great moment, catches glimpses of the black dot in the sky; ocean steamers, bearing each a cityful of human beings, train thousands of glasses on the tiny winged thing, advance herald of the aerial age. Above all he rides, solitary, intent. There will be no time to decorate for his coming; flags will run up hurriedly, roofs in an instant turn black with people, wharves and streets white with upturned faces, while over the heads of the multitudes he rides in, to such a shout as the ear of man never heard. No explorer ever knew such a welcome, no conqueror, as awaits the Columbus of the Air."

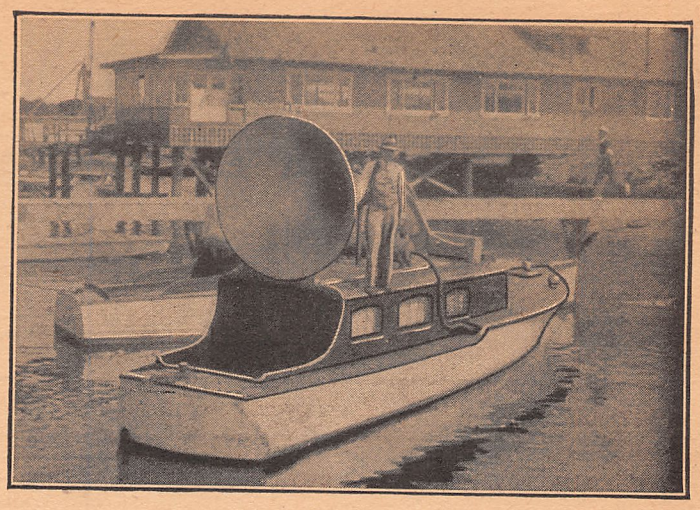
Arthur H. Lynch

Editorial Director.

Giant Speaker of Four-Mile Range

Human Speech Organs are Imitated on Huge Scale in this Super-Power Radio Reproducer

By C. Sterling Gleason

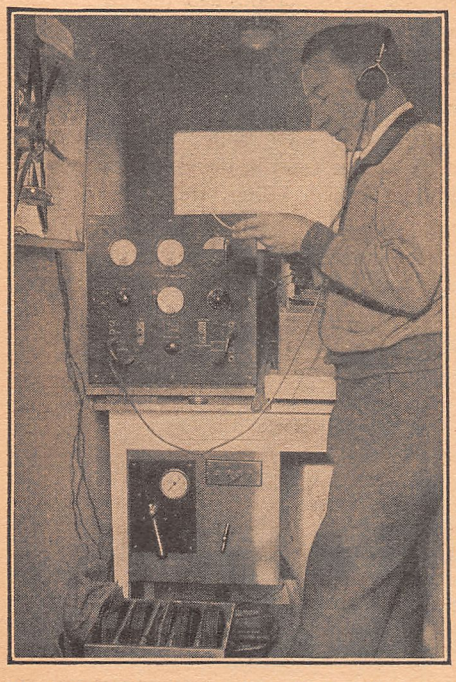


Mounted on a boat for the use of officials of the Newport Beach, Calif., Yacht Club at a regatta, this speaker carried speech intelligibly for miles.

THE city of Los Angeles, California, has a new town crier. That quaint figure, an anachronism in these days of great cities and thunderous traffic, has long been missing from our modern world. But now, given a new voice so powerful that it can be heard for several miles, he can again cry out the news to all the people of the town, as in days when a city was bounded by castle walls.

The modern crier, riding in a sound-proof cab upon a large truck, speaks to the world through a microphone—and the whole city hears. The device which enables him to address the world in such stentorian tones is a powerful speech-amplifier unit coupled to a new type of loud speaker which imitates the action of the human throat and larynx—thus giving the same quality that enables a tenor to fill a large auditorium with a round, robust tone, yet without the least strain on the part of the singer.

Designers of the exponential type of loud speaker are familiar with the fact that the action of the speaker's diaphragm sets up a "standing wave" in the horn, and that the horn must be quite long in order to compare favorably with the wavelength of the low bass notes. The action of the ordinary horn may indeed be compared to that of a man whispering. Air, set in vibration by the vocal cords, carries sound through the throat and the mouth, and the quality of tone is controlled by the movements of the lips, tongue and palate. But, to produce a large, robust tone capable of filling a large room, the words must be *voiced*—more air must be forced out by the pressure of the diaphragm, so that the air all about is set in motion. In this same principle is the secret of this speaker's huge volume. The air, set in motion by a powerful air compressor, is controlled by a set of "vocal cords" which impress upon the moving air column the vibrations of the sound impulses originating in the speech amplifier. The sound is literally blown out of the speaker, instead of merely setting up standing waves in the horn; and the resulting disturbance in the air carries over great distances.



Frank Hetzel in the sound-proof microphone room of the truck, described here. The dial registers air pressure. The box of records below furnished phonograph programs.

CONSTRUCTION OF THE SPEAKER

The huge instrument was built at a cost of $15,000 by Hetzel Brothers of Los Angeles, for the purpose of publicizing their business. The installation as a unit is mounted upon a platform which normally is fastened to a truck chassis, but which is demountable at will; so that it can be transferred bodily to any place it is desired—for example, the deck of a boat.

Upon the forward part stands the microphone room, a compartment four by seven feet in size and seven feet high, and located, when mounted upon the truck, just behind the driver's cab. In order to prevent the sound from being picked up by the microphone (thus causing a howl like that resulting when a telephone receiver is held up to the mouthpiece) it was necessary to insulate the microphone room completely from sound. To this end, the walls were made double, and the four-inch space intervening was filled with a special sound-deadening compound. The windows, of which there are four, permitting the operator to look in every direction, are likewise double, so that when the door is closed the room is virtually sound-proof. Here is located the pick-up and speech amplifying equipment. A large, studio-type microphone and a phonograph tone-arm pick-up make it possible to alternate voice and music, or to superimpose one upon another, merely by throwing a switch. Voice currents are fed into a stage of straight audio-frequency amplification, and then through a second push-pull stage into the real high-power circuit. This is a push-pull stage employing two fifty-watt power tubes operated at 1,000-volt plate potential.

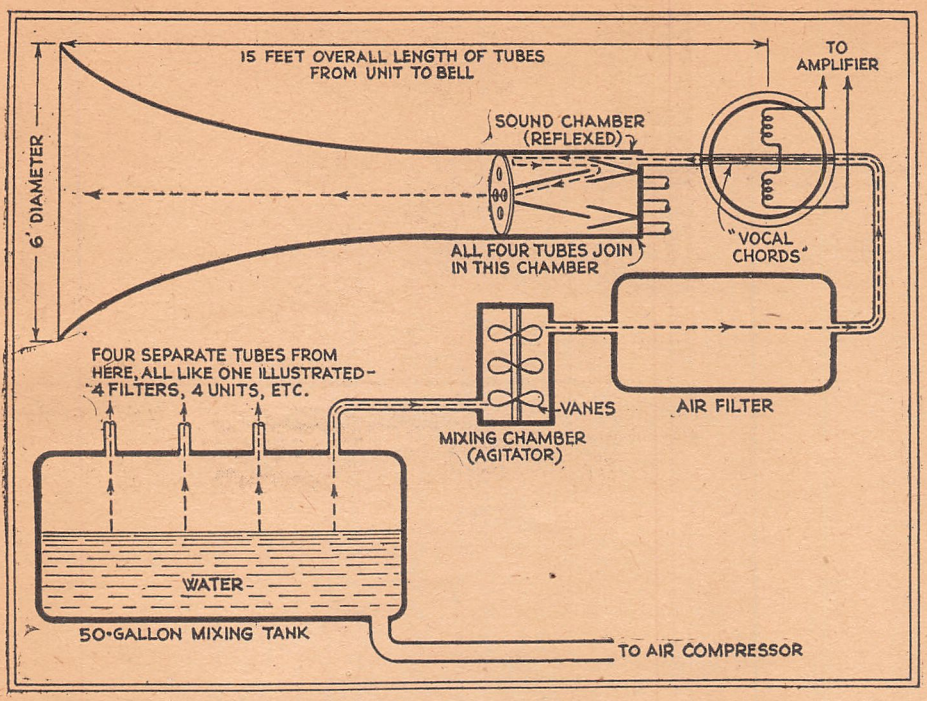
The power supply for the entire system is derived from a sixty-horsepower gasoline engine, mounted upon the speaker platform, and running independent of the truck's motor. This drives not only the 1000-volt D.C. generator for the plate supply, but also the four-cylinder air compressor providing the air blast, as well as two six-volt D.C. generators for charging the storage batteries used as filament supply.

THE GIANT'S THROAT

The most interesting feature of the installation is the horn itself, which almost exactly duplicates the action of the human vocal mechanism. The "lungs" of the device are the air compressor, which delivers a stream of air into a large "mixing chamber." Just as the human larynx must be kept moist by the saliva, so this loud-speaker requires a high humidity for the proper operation of its speaker unit; and consequently this mixing chamber contains a quantity of water, from which the air, churning through, absorbs a considerable percentage of moisture. Surplus water is allowed to settle out in a second chamber and the drenched air, now drawn through an agitation chamber containing a whirling, many-bladed fan, is whipped into a very fine mist or fog of invisible particles of moisture. This mixture, passing into the *"larynx"*—which is constructed in quadruple, so that the speaker is actually four in one—is modulated by the speech currents, which drive the vibrating elements corresponding to the human vocal cords.

Four "throats," each about three inches in diameter and nine or ten feet long, coiled about in the familiar manner of the reflexed loud speaker, conduct the sound-blast to another mixing chamber. Here the moisture-laden air is given a final whirl before it is expelled through the horn, which flares suddenly from this point.

The tremendous power of the speaker is shown by the fact that the four air columns, resisted by baffles contained in the last mixing tank, pound like a trip-hammer against the chamber in pulse with the fluctuations of sound. Nevertheless the horn itself does not vibrate at any part of the frequency range, for it is built of 3/16-inch steel. The heat dissipated in the compression of the air raises the temperature of the horn above


15 FEET OVERALL LENGTH OF TUBES FROM UNIT TO BELL
TO AMPLIFIER
SOUND CHAMBER (REFLEXED)
6' DIAMETER
"VOCAL CHORDS"
ALL FOUR TUBES JOIN IN THIS CHAMBER
FOUR SEPARATE TUBES FROM HERE, ALL LIKE ONE ILLUSTRATED—4 FILTERS, 4 UNITS, ETC.
VANES
AIR FILTER
MIXING CHAMBER (AGITATOR)
WATER
50-GALLON MIXING TANK
TO AIR COMPRESSOR

The lungs, windpipe, sound-box, and "vocal cords" of the gigantic reproducer, whose throat and mouth are the huge horn pictured below. The resemblance to human speech apparatus will be readily recognized. The details by which the vocal cords are connected to the audio amplifier and operated are not made public by the builders.

the boiling point of water. This is power indeed!

The quality obtained is superlative, particularly when one considers the tremendous volume that is handled without apparent distortion. Although so far no quantitative measurements have been taken, the designers believe that the frequency range of the speaker extends downward to the neighborhood of five cycles, and the fidelity with which the bass section of the orchestra is reproduced bears out this statement. The kettledrum acquires a new individuality, and one almost longs to hear it as a solo instrument, so beautifully does its resonant nature stand out in this extraordinary speaker.

It should perhaps be pointed out that the tremendous amplification obtained with the outfit is due in a large part to the speaker itself, which gives huge amplification independent of the speech amplifier. Indeed, the electrical equipment is used merely as a matter of convenience; since it is possible to operate the loud speaker by the mechanical vibration of voice waves only, without the aid of electrical amplification. The combination of an amplifier like the one described, with this speaker, gives an instrument unrivalled in quality and volume.

In addition to the reproduction of speech from a microphone, and music from records, the apparatus is in almost daily use for radio programs sponsored by the owners, who are brake engineers, as well as for general advertising. When it was used on a boat, as illustrated, it commanded a price of $300 an hour. The horn, at a distance of a mile from shore, was clearly understood, and its attention value was high.

THE BUILDERS' SECRET

The inquiring reader must be disappointed here, if he is in search of details sufficient to construct a speaking horn of this type, if not of such heroic size. The makers of this horn decline to make public the exact nature of the method in which the audio-frequency currents are applied to regulate, or modulate, the air blast; stating that they have spent several years in the development of this mechanism, and that the protection of the idea rests, not in patents, but in the difficulty of imitation. The construction, moreover, is both delicate and complex, and requires a high degree of precision in adjustment.

The "vocal cords," which must be capable of responding to very quick changes of current, incorporate solenoid coils, it is stated (and, presumably, electro-magnets) which work against the air blast. In the construction of this voice-box, there are leather, rubber, steel, linen, rawhide, bamboo, tungsten, magnesium, silica, and other materials. The mechanism thus intriguingly composed regulates the passage of air, just as the human larynx does the voice. No hissing or "fricative" ("rubbing"—such as the sounds of *sh*, or *th*) sounds are introduced by these vocal cords, as in some apparatus previously designed for similar purposes. A certain high-pitched rattle can be detected at close range, by holding the hands over the ears; indicating that the vibrating element has a natural frequency like that of certain headphones, and that certain parts of its assembly are under high tension.

It is easy to form an idea of the principle upon which the 'vocal cords" are actuated by alternating current—that of the pull of magnets alternately increasing and relaxing. However, when the necessary elements of design are considered, and the delicate balancing required to make the tremendous voice seem at all human, the amount of labor involved can be imagined.

At the right, another view of the speaker as used on the Hetzel motor cruiser. The compressed-air tanks are seen below the tubes which carry the monster horn's breath.

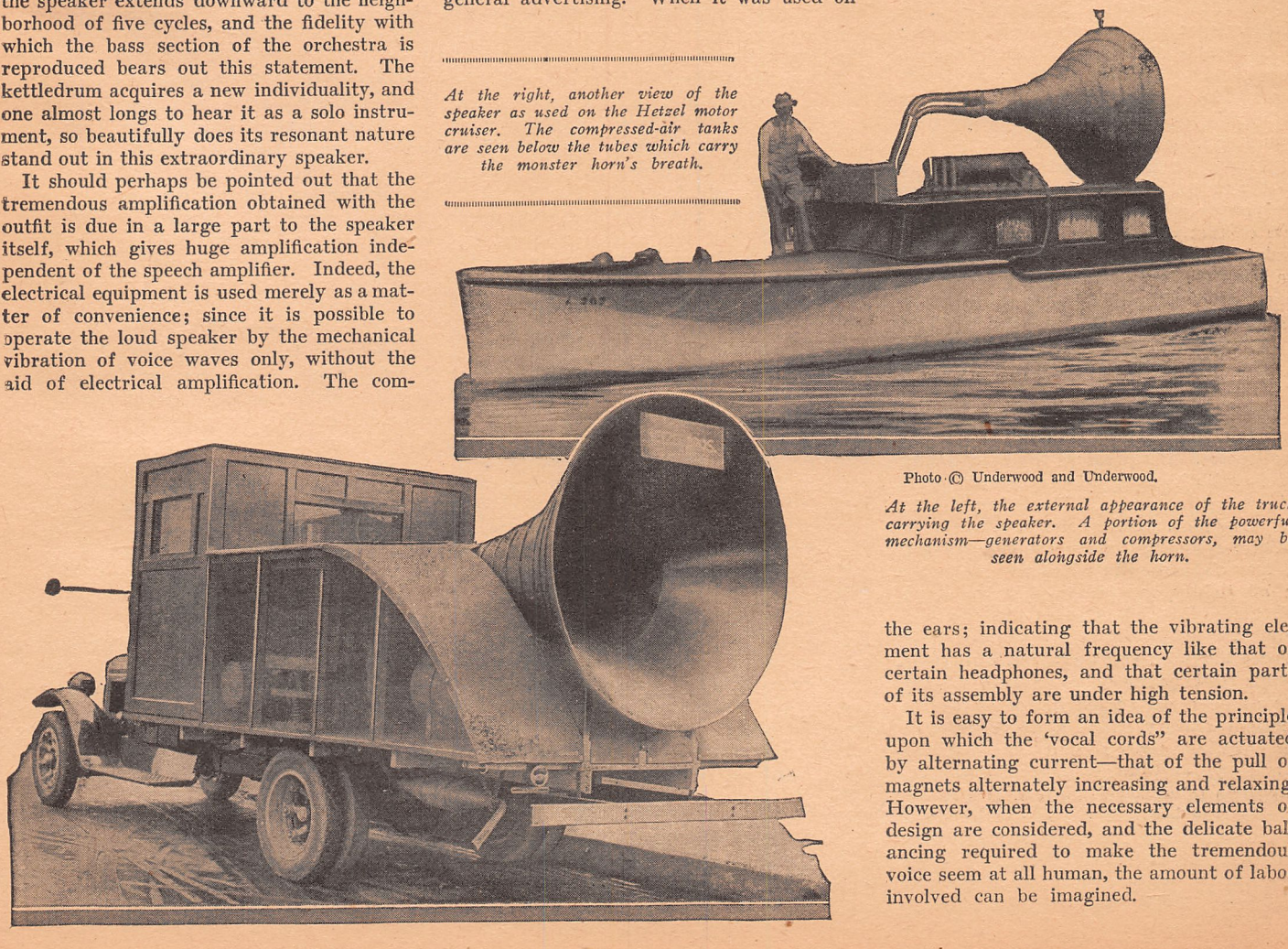
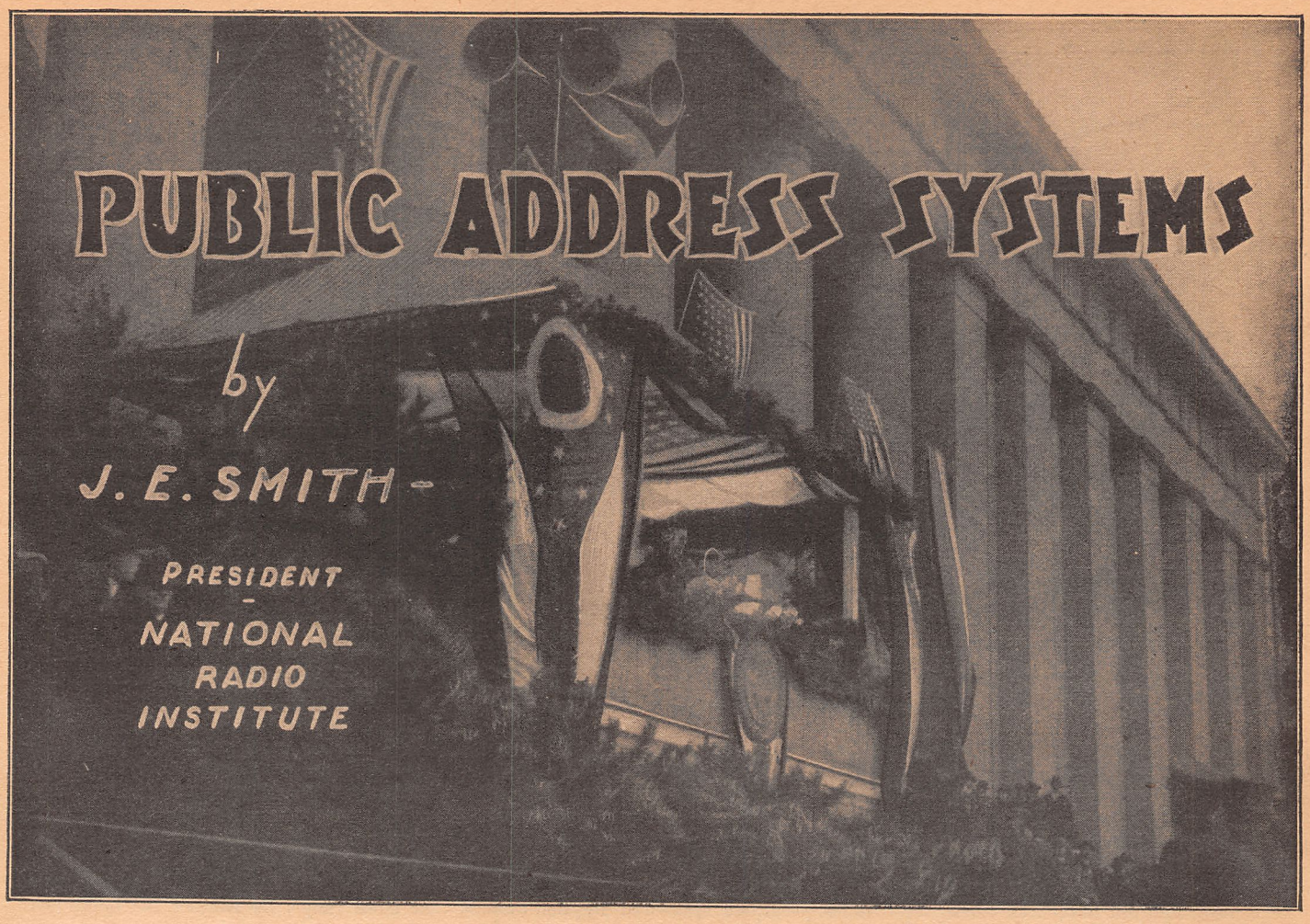


Photo © Underwood and Underwood.

At the left, the external appearance of the truck carrying the speaker. A portion of the powerful mechanism—generators and compressors, may be seen alongside the horn.



EVERY new improvement which science provides for overcoming the age-old obstacle of distance gives another great impetus to man's knowledge and to the advance of civilization. Just as the printing press has extended learning throughout the world, as the railroad and the automobile have broadened our vision and the extent of our acquaintanceships, so Radio has brought us all into direct and personal contact with one another. The recent development of public-address amplification adds still another link to the chain of modern communication—by making available to a multitude the same personalized message which heretofore could be grasped by only an individual or a small collective group.

Ever since man first came into being, his steady striving has been to increase his own effectiveness. His progress has been tightly tied up with his ability to address, impress, and convert or educate, his fellow-man to each new idea. Governments, whole civilizations, schools of culture and philosophy, the very civilization in which we live today, are all tightly and indissolubly bound up with the rapid and effective dissemination of ideas.

Three thousand years ago, one man could address just as many other men at one time as he could at the beginning of the twentieth century. Not a single forward stride had been made during three thousand or more years towards increasing the effectiveness of personal address.

But in the last few years man has been enabled to reach out and talk to, not paltry hundreds, but literally thousands upon thousands of other men at one and the same time. Radio has made this possible, but, like most machine inventions, it has at the same time shorn the speaker of his visible personality.

Today, through public-address amplification, a man may talk to, and at the same time bring the full force of his visible, physical personality to bear upon countless thousands of his fellow-men. It is today possible to be brought from afar into the vital, living presence, and hear the unstrained natural voice of a speaker; who a few years ago would have seemed but a straining pygmy, impossible to understand, far away across the heads of a swaying crowd.

MAN MAGNIFIES HIS VOICE

For instance, the preacher in some architectural masterpiece of a cathedral may be delivering his sermon to an attentive congregation, swelled to overflow by those anxious to hear his words. He may be old, possibly feeble and ill, and his voice, perhaps, is weak, though his message vital and strong. The members of the congregation strain forward to catch his words, while the very nooks and crannies that contribute to the beauty of the edifice seem to conspire to absorb and deflect his voice. We all know this sensation of straining to catch a word here and there—but how many have ever had this experience after a public-address microphone, amplifier and horns have been installed, and the speaker's voice comes out full and clear to even the farthermost recesses?

To go to an opposite extreme—a prize fight in a large and crowded hall or stadium. With the big bout of the evening about to start, the announcer draws himself up, expands his chest and shouts an unintelligible series of names successively in four directions to a seething, whistling mass of humanity, only to stagger out of the ring, his lungs exhausted in an effort that conveyed, perhaps only to his nearest listeners the names of the fighters. Suddenly the public-address system is turned on, and in a great voice, clear and natural, the entire audience is told of the next event by a man at the ringside speaking in a low voice, into a small, round microphone. And if the crowd yells and howls, up goes the volume of the unstrained voice until every last man has heard the announcement, clearly and distinctly.

Again, at a country fair a prominent citizen makes an important address. It may be heard by only a comparative few of the strolling crowd, many of whom are intent upon the exhibits. In a second, the public-address amplifier is turned on, and from loud speakers all over the fair grounds issue the words of the speaker, unstrained, poised, unhurried, and, above all, clear and distinct.

A political stump speaker, travelling from ward to ward of a large city, talks to each group of constituents far into the night. If his car is provided with a public-address amplifier, at each stopping point he requires merely an extension cord, plugging into a nearby lamp socket for power; and easily, without fatigue, he addresses large crowds through two loud speakers mounted on the top of his car—without having even to stand on top of it—and is heard a block away!

UNIVERSAL EDUCATION

The schools of every progressive city and township are arranging to benefit from the Walter Damrosch concerts. Here, public-address amplifiers are indispensable, for no

single, standard radio set is powerful enough to do justice to Walter Damrosch's music in the larger classrooms. But the school that installs any good radio set, augmenting it with an address-amplifier, can recreate the symphony orchestra's programs at full, natural, undistorted volume, either in the school auditorium, or in from ten to twelve separate class rooms, all at one time.

These illustrations serve to suggest merely a very few examples of the forward strides made by public-address amplification. It is hardly necessary to add such applications as factory or office-building call systems, hotel and apartment-house installations; systems for picnic, newspaper, athletic field, and a host of similar needs which a public-address amplifier can satisfy.

To our children, public-address amplification will be as commonplace as the telephone is to us, and the benefits that it will confer need not be withheld a single day. Today no progressive municipality would think of building a school, community center, auditorium, fair-ground, or even a hotel, without arranging for suitable amplification, for the benefits it brings are truly marvelous.

DEVELOPMENT OF THE AMPLIFIERS

This great development, like many others, can be classified under some of the various applications of the vacuum tube. One of the first commercial uses of the vacuum tube as an amplifier was in wire telephony. The losses encountered in the electrical transmission of the voice over a telephone line had limited the usefulness of this invention to the distance that could be covered in such cases. With the advent of the vacuum tube and understanding of its ability to amplify and reproduce exactly electrical impulses, its value in wire telephony was soon recognized. Without going into the details of this application, the result was that amplifying stations were distributed along the transcontinental telephone lines; so that the line losses could be made up by amplifiers and the listener at a distant point became able to hear a speaker's voice with the usual clearness and natural volume. This all occurred before broadcasting came into being or, rather, was made use of as a public entertainment feature.

Far-sighted research engineers soon conceived the idea that it was entirely feasible to place a microphone before a public speaker or entertainer and pass the electrical impulses created in the microphone into an amplifier, thus reproducing the speaker's words in such a way that he could be heard by a vast audience. Development work was soon started along this line, with the result that a speaker was able to be heard by a larger audience and in a manner which exactly reproduced his own voice.

As stated in a previous paragraph, the public-address system consists essentially of four separate component parts: first, a microphone upon which sound waves are impressed and converted into electrical impulses which vary in frequency according to the frequency of the sound waves impressed on the diaphragm of the microphone; second, a vacuum-tube amplifier consisting of several stages of audio-frequency amplification, the exact number of stages required being determined by the strength of the electrical impulses created in the microphone and the required volume of reproduced sounds; third, reproducing units which convert the amplified electrical impulses into sound waves; fourth, the power-supply unit which supplies the electrical power necessary to operate the microphone, amplifier and reproducing units.

As a further expansion on this subject, let us now go into detailed study of the various units previously characterized.

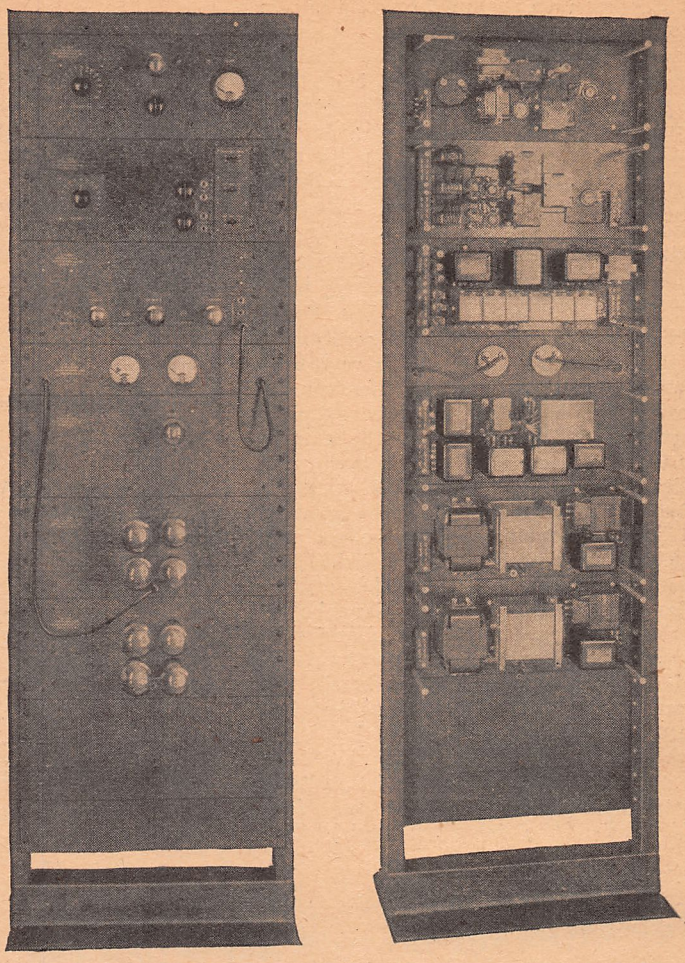
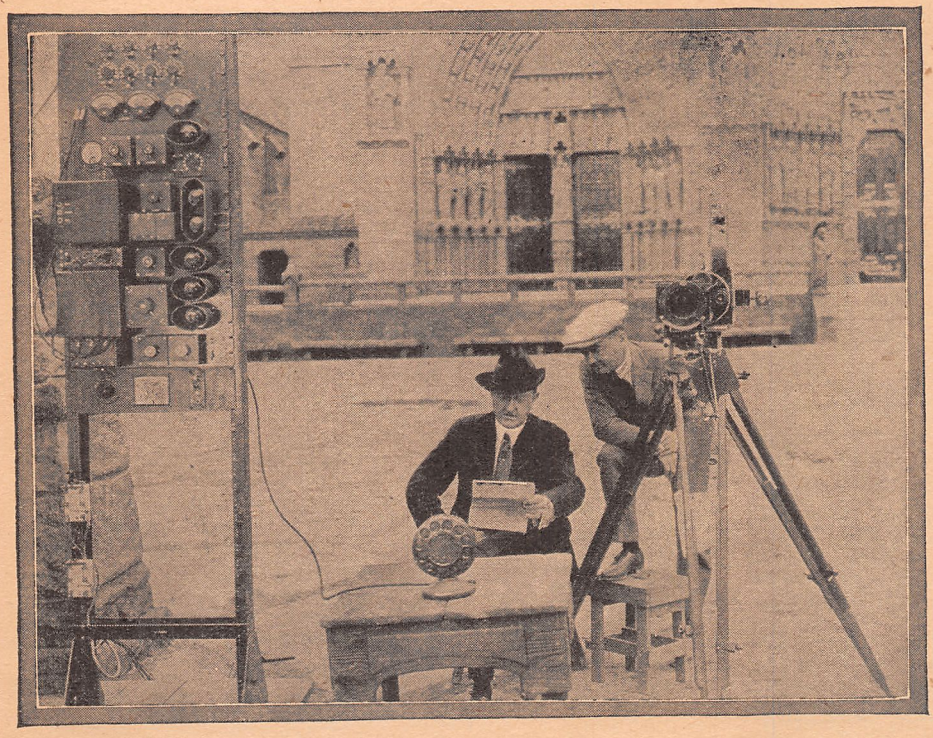


Fig. A

An elaborate public-address system, in its steel rack; it is a permanent installation for a large building. (Photo courtesy Silver-Marshall, Inc.)



A public-address system set up "on the lot" and used to direct the army of supers required in filming the motion picture "The Hunchback of Notre Dame." This photo and that in the heading of the article, showing an installation at the Ohio state capitol, Columbus, by courtesy of the Graybar Electric Company.

MICROPHONE TECHNIQUE

The function of the microphone is to convert the sound waves impressed upon the diaphragm into electrical impulses which vary exactly with the frequency of the sound waves. Considering the fact that high-quality reproduction is desired, a very high-class microphone is essential. The usual broadcast, or studio-type microphone, commonly used for radio pick-up purposes is usually incorporated in public-address systems. It is constructed along lines of research that have been followed during the past twenty-five years (Such an instrument was fully described and illustrated in Radio News for May, 1928, "Folks, Meet Mike.")

Most broadcast microphones will not operate in other than an upright position. The proper protection, in the form of a collar, is provided to eliminate the possibilities of damage to the diaphragm, which is ordinarily occasioned when the microphone is improperly handled. A third, or center leg of the microphone is provided on the edge of the frame, and the battery connection is made thereto. Thus there are three connections to this microphone, and these connections should go to a battery and the input of a "modulating transformer"; the schematic connections are shown in Fig. 1.

High-grade microphones are constructed so that extraneous noises cause very little fluctuation of the diaphragm; therefore the speaker or entertainer must be properly placed before the microphone. By stretching the diaphragm and by other means the undesirable noises outside the speaker's voice are eliminated; but the diaphragm can not vibrate as much as in the ordinary telephone microphone. The electrical impulses are, therefore, much weaker and require amplification before they can be reproduced with natural volume. High-grade or broadcast microphones are usually classified as being so many "miles down"; this phrase means that the electrical impulses are comparable to electrical impulses which have been sent through a standard cable of so many miles length. When transmitting electrical impulses through a very long cable such as a telephone cable) "line losses" occur which must be compensated for by amplification and so it is with a microphone.

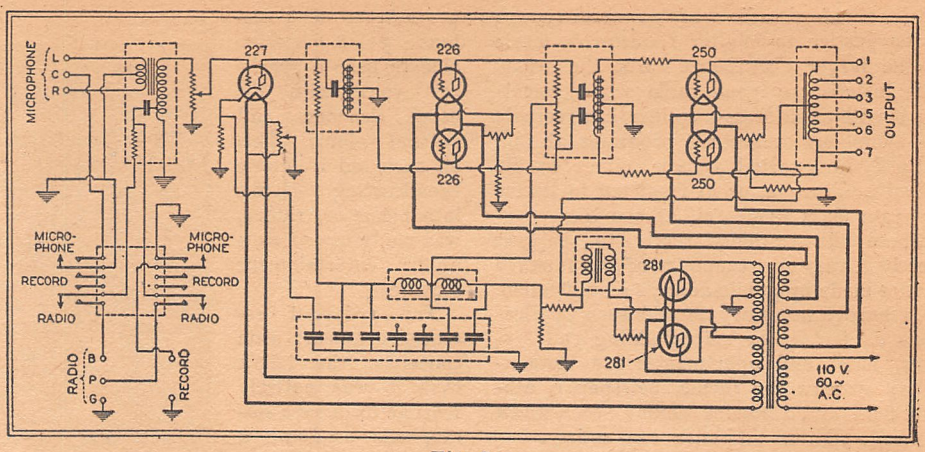


Fig. 3

One of the new Silver-Marshall 690 amplifiers, capable of feeding thirty-two speakers at one time.

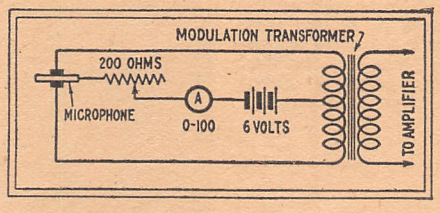
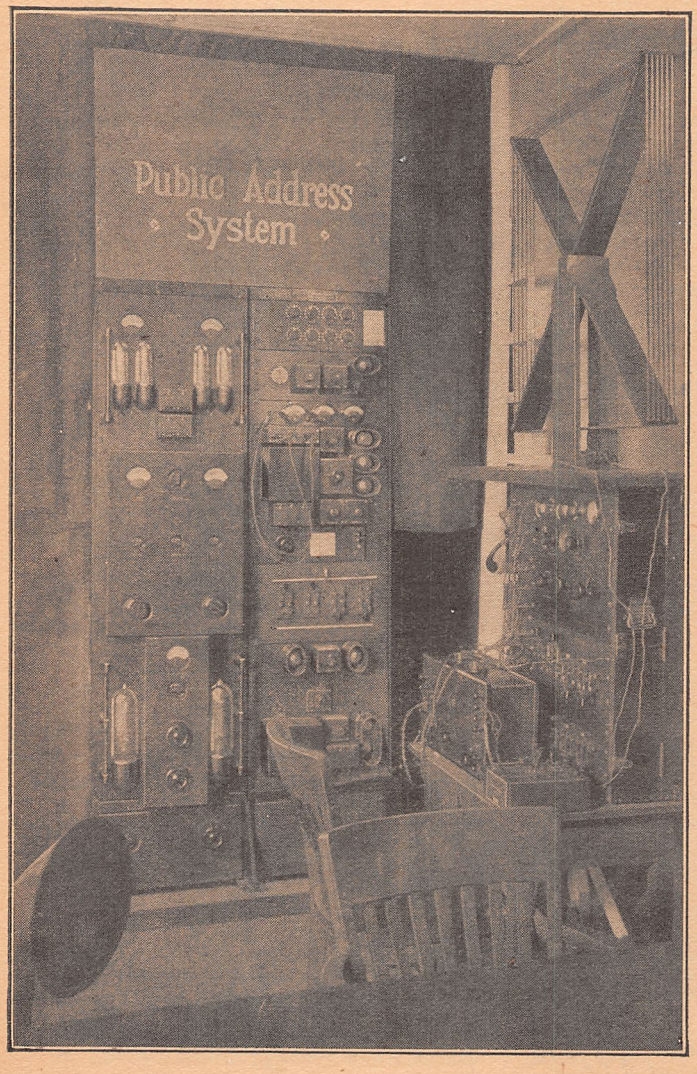


Fig. 1

How a standard microphone is hooked up.



The ordinary broadcast microphone has a characteristic of something like "forty miles down." Roughly speaking, this means that three stages of a power amplifier will bring this up to the volume of about a person's ordinary speech. The current through most carbon microphones is in the neighborhood of ten to twenty milliamperes (the battery, milliammeter and rheostat being placed in the third or center connection of the microphone); this is the total current through both buttons, there being one-half this current through each button. The direct current resistance of each button or elcetrode is approximately 16 ohms. Of course, figures vary for different types of microphones; but these are given to familiarize the reader with the approximate amount.

Every broadcast microphone should be equipped with a proper protective housing to eliminate the possibilities of damage to the instrument. The usual stand has a number of eyelets so that the sound waves may be properly impressed upon the diaphragm. Usually springs or rubber bands are used to support the microphone inside of the stand thus doing away with undesirable vibrations of the microphone proper.

Best results are obtained from a microphone when it is used in conjunction with a modulating or microphone transformer of correct impedance. Although the impedances of the various types of microphones differ considerably, one such modulating transformer has a very large core and the complete transformer weighs about two pounds. It has an amplification curve practically even from 90 cycles upward to 5,000 cycles, falling off very little below 90 cycles. The primary impedance is 28,400 ohms and the secondary impedance is 390,000 ohms at 60 cycles, the primary inductance being approximately 90 henries. It goes without saying that the secondary of this transformer is connected to the input circuit of a vacuum tube and thence so on through the amplifier proper.

It is possible to substitute, for the direct input from the microphone, an instrument whereby phonograph records may be used as a source of entertainment, in addition to the actual human voice or musical instruments present in the auditorium. This is accomplished by the use of a "pick-up," of the type described at length in the previous (April) issue of Radio News—pages 914-915.

Fig. C

This W. E. system uses 50-watt tubes, shown at the upper left. On the table are a superheterodyne receiver and the battery control system. The amplifier panels at the left are built in units of various standard sizes. See page 1043 for the diagram of one. (Graybar Electric Co.)

THE VOICE AMPLIFIER

The amplifier used in a public address system is purely an audio-frequency amplifier. Since the frequency of the electrical impulses lies within the limits of the so-called voice range, all that has been learned of audio amplification in the past can be applied in this instance. Instead of having the output voltage from the detector of a radio receiver, we merely have the voltage developed in the modulation transformer.

Since the microphone is rated as several miles down, it is necessary to use two or three stages to amplify the electrical impulses and have the reproduction of normal

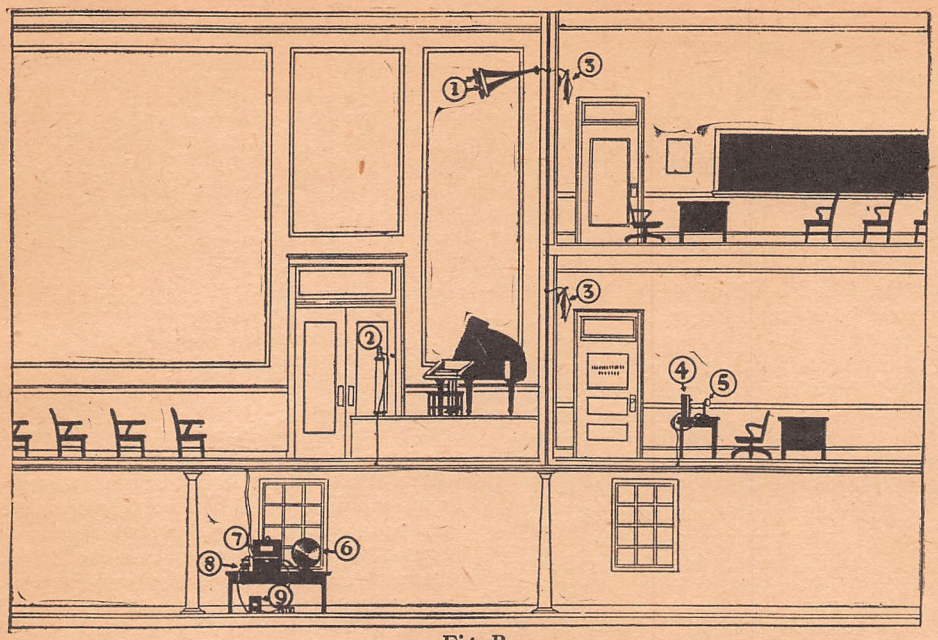


Fig. B

Typical W. E. small-school installation; controlled from board 4 in the principal's office; microphones 2 and 5 are connected at will, or a receiver. The amplifier 7 has its "monitor" 6; the auditorium has horn speakers 1, classrooms cone speakers 3. The power supply is at 8 and 9.

speech volume. Then, if several loud speakers are to be operated, power amplification must be used to increase the volume above the normal amount. Therefore, it becomes apparent that the number of stages needed in the amplifier depends both upon the type of microphone used and upon the volume of the desired reproduction.

For a small hall, where one or two loud speakers will suffice, only two or three stages without power amplification may be used. Where great volume is required in a large assembly hall, or for reproduction in the open for a multitude, the number of stages must be increased accordingly. Each loud speaker requires a certain amount of power and, taking this into consideration, the amplifier must be designed accordingly. In large public-address systems, power tubes with an output rating as high as 50 or 200 watts are often used. *Every installation is an individual problem which must be dealt with as such.*

THE REPRODUCING UNITS

Ordinary loud speakers will, generally, meet the requirements for a small public-address system. One power speaker may be used to deliver a greater amount of volume but, for a large assembly hall or for open-air reproduction, several such speakers may be required. The acoustic condition of the hall or the surrounding country must be taken into consideration and the speaker placed accordingly. The echo effects and reverberation usually cause considerable trouble and, in such conditions, the best policy is to use several ordinary speakers instead of a power speaker and place them in such a manner that the echo effect is minimized.

In some cases a number of ordinary speakers are grouped and, for such events as a national convention in an exceedingly large assembly hall, groups of these speakers are placed at various points throughout the hall. Usually considerable experiment is required to determine the correct locality of each group of speakers. Also, the echo and reverberation effects will vary considerably. More echo will be experienced when the hall is empty; while more volume is required when the hall is filled with people.

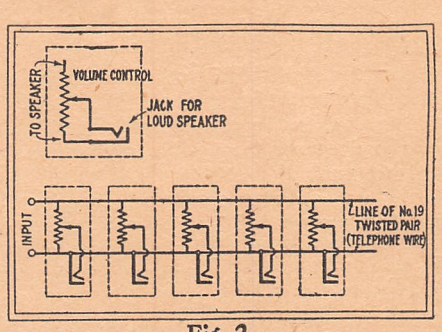


Fig. 2

In this manner each speaker is given its own volume control without affecting others.

As in the case of the amplifier, the exact number of speakers required may be compared to the number of stages of amplification; each installation presents an individual problem and must be solved usually by experiment in order to determine the best conditions.

A COMPACT ADDRESS AMPLIFIER

One of the amplifiers here illustrated is a portable light-socket operated power amplifier; it will amplify the output of a microphone, magnetic phonograph-record pick-up, or the output of a radio detector tube up to an undistorted power level of five watts. This power is sufficient to give intelligible high-quality speech and music through from one to six large loud speakers for auditorium, theatre, church or outdoor-grandstand coverage of 2,000 to 10,000 people. This output will also operate up to twelve standard radio loud speakers at ordinary home volume, with the speakers located in different rooms of a building, as in a hotel, school or apartment house. Loud speakers may be located up to 500 feet away from the amplifier; connections from microphone, radio set or pickup should be as short as possible and not over 50 feet long. A control knob is provided to regulate volume smoothly from a whisper to full maximum.

This apparatus is mounted upon a heavy steel bulkhead, to which a tube-socket shelf is attached, and fastened in the center of a steel case which is provided with a hinged cover over tube compartment, ventilating louvres and two carrying handles. Binding posts are provided for loud speaker, radio or record pick-up, microphone and microphone battery connections. Such equipment weighs approximately seventy pounds and may be used, not only as a portable amplifier, but permanently installed either indoors or outdoors. If instantaneous change-over from radio, record, or microphone amplification is required, external switching is necessary.

Two UX281 rectifiers, one UX250 power amplifier, one UX226 A.C. amplifier and one UY227 A.C. amplifier tubes are required for operation, in addition to input apparatus and loud speakers. (This apparatus, illustrated here, is the Silver-Marshall Unipac; a more powerful amplifier is diagrammed on page 990.)

It is well to emphasize the fact that satisfactory public-address operation may not be had by merely installing equipment without thought and trial, and expecting it to work perfectly. Each installation requires individual experiment over a period of several days or even several weeks; for upon the carefully worked out and tested placement of loud speakers and microphone depends the degree of satisfaction that will be obtained.

(*Continued on page* 1043)

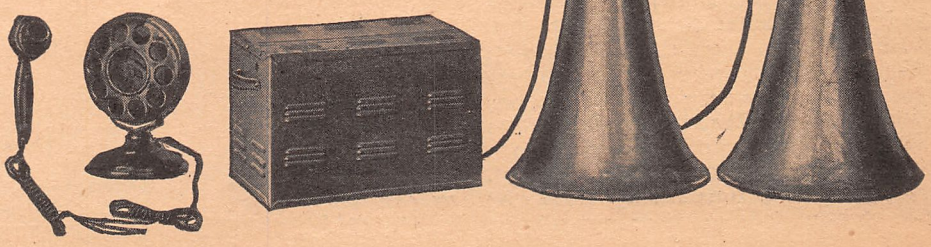
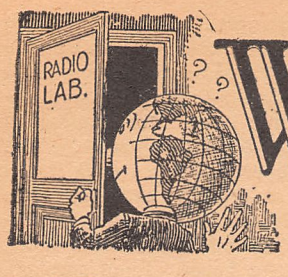


Fig. D

A highly-portable Silver-Marshall amplifier with two of its speakers and microphones. One system of this type is described above.



What's New in Radio

All apparatus described in this department has been tested in the Radio News *Laboratories and found of high quality in design and construction.*

A Dynamic Speaker With Built-In Power Supply

THE dynamic speaker illustrated in Fig. A is of a new design; however, like other moving-coil speakers, it consists essentially of a "field" and a "voice" coil. The former has an iron core of high permeability, of which the pot encasing the windings is an integral part; on this is mounted a steel spider frame guarding the small cone diaphragm. The last is flexibly connected to its ring, and rigidly attached to the small "voice" coil which carries the output signals of the audio amplifier operating the speaker. This coil moves freely across the gap within the field coil, where the magnetic flux is maintained at such a density that it is not affected by the motion of the coil, but exerts on the latter a constant influence. The moving coil, therefore, moves back and forth in accordance solely with the A.F. currents which it is carrying; being repelled in one-half of each cycle and attracted in the other.

The essential assembly above described is termed the "head"; and is in itself a complete reproducing unit. In practice, however, it requires also certain accessories before it may be used with an ordinary radio set; so, in the model illustrated, the head is attached by mounting brackets to a steel base which carries a universal output trans-

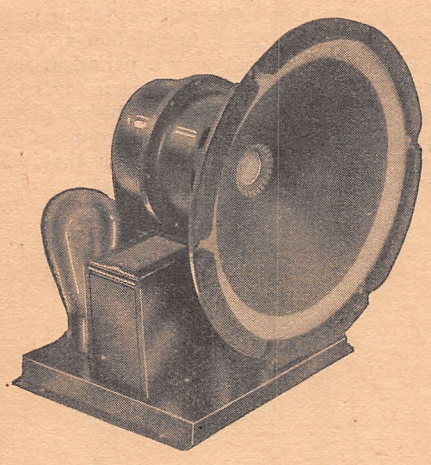


Fig. A

Together with the speaker unit proper, as shown, an input transformer to connect it with the power tubes, and a rectifier tube working from the light circuit are mounted on the steel base furnished. The rectifier is omitted if a D.C. current supply is to be used.

former and a power-supply unit providing direct current to excite the field coil. In the 850-type speaker illustrated, this power-supply unit operates directly from a 105- to 120-volt, 50- to 60-cycle A.C. lamp socket; while in the otherwise similar 851-type speaker the power supply and its base are omitted entirely. The 1900-ohm field coil in the latter design must be connected to a source of 90- to 120-volt direct current, which is obtained from one tap of the "B" unit of a receiver or, more economically, by the inclusion of the field coil as a choke in the filter circuit of the "B" unit. The circuit is shown in the accompanying diagram (Fig. 1).

Each unit is equipped with a universal output transformer of wide application, designed to operate at maximum efficiency from a push-pull amplifier using either two 171A, two 250 or two of the new intermediate (2½-volt) power tubes; this is of the same general characteristics as the transformer employed in the S-M rack-and-panel amplifiers. From this transformer a special tap is taken out at the exact point to provide most efficient operation from a single output tube of either of the sizes named above; while the entire primary winding matches one 210 tube for conditions of maximum undistorted output. The transformer is designed to avoid core saturation under the plate current of one or two 250 tubes.

While these units are ideal for home operation, the very characteristics that make them so have been accentuated to make them particularly suited to public-address work at high power. Each unit is constructed to handle two or three watts of signal energy for theatre, auditorium, or outside use. For such work, combinations should be used of one or two baffles, four to six feet square and ten inches deep, made of ⅞-inch lumber, with from one to four dynamic units closely grouped in the center of the baffle. For 500- to 1,000-seat theatres, one or two units in individual baffles are recommended, to be fed by one 250-tube in an amplifier; for 1,000- to 2,000-seat theatres, two baffles, each with two to four units fed by two 250-tubes in push-pull.

The 850 A.C. dynamic unit requires one 280 full-wave rectifier tube for operation; its cone frame has a 9-inch outside diameter (to fit an 8¾-inch baffle opening), is 6⅝ inches deep, 10 inches wide over power unit, and weighs about 15 pounds.

The type 851 speaker is identical except that, since it is intended to obtain 40 to 50 milliamperes of field current from a D.C. source, as described above, it is not equipped with rectifier or base.

Either type may be mounted by being placed upon (or screwed to) a cabinet bottom, or fastened directly to a flat vertical baffle with six wood screws. A suitable baffle is, of course, essential with each unit to give full tones.

Manufacturer: *Silver-Marshall, Inc., Chicago, Ill.*

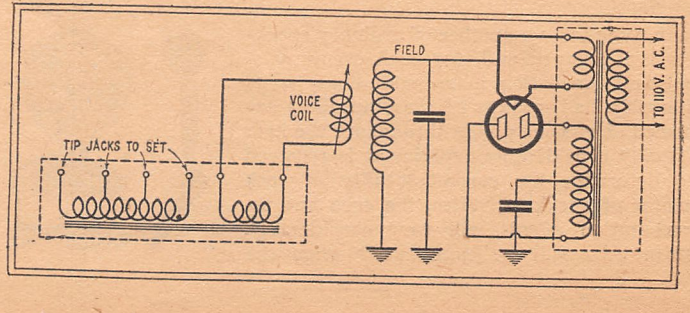


Fig. 1

A diagram of the speaker assembly shown in the first column; the voice coil, of course, carries the moving cone and is placed in the gap of the field coil, which is electrically separate. The latter is fed with direct current, obtained through the 280-type rectifier from the house line.

Short-Wave Tuner of Flexible Application

THE apparatus illustrated in the two views herewith, which bears the stamp of careful engineering on its face, is a short-wave tuning unit, the product of a well-known New York manufacturer, to whose other material it bears a strong family resemblance in style and finish. The complete equipment, which comprises two stages, is housed in a sturdy aluminum cabinet which serves the dual purpose of supporting and protecting the assembly and of isolating it from other apparatus.

A set of several interchangeable plug-in coils allows of reception over the wide band of wavelengths below the regular broadcast

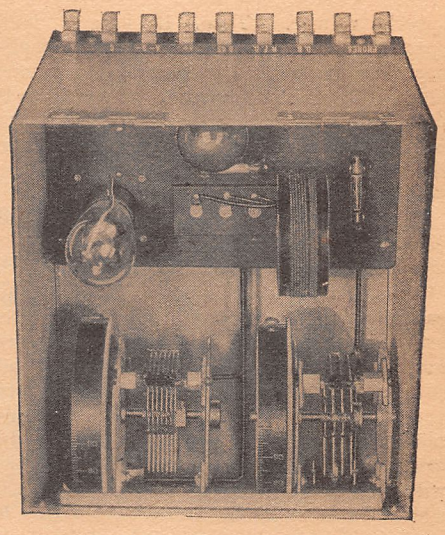


Fig. B

Interior view of the short-wave tuning unit illustrated and diagrammed on the opposite page; the tube at the left is a 222-type.

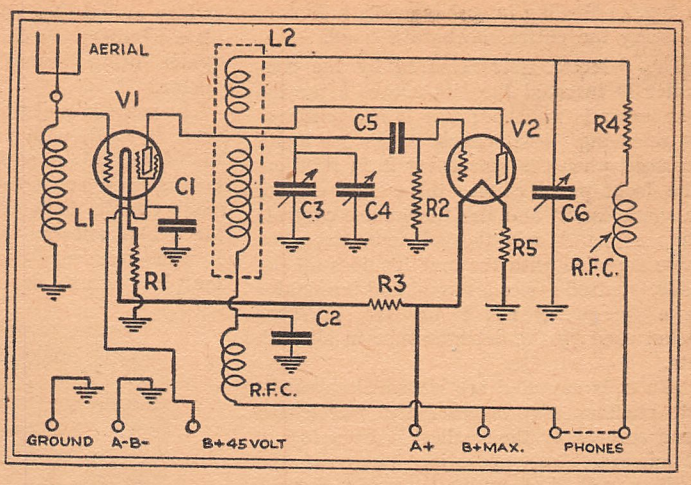
band—from 15 to 200 meters. Interchangeability is accomplished by mounting each inductor on an insulating strip, equipped with small plugs which fit into pin jacks. Three sets of these coils are illustrated on the external view of the assembly. Since the range of each coil overlaps those of its neighbors, there is no wave uncovered in this band.

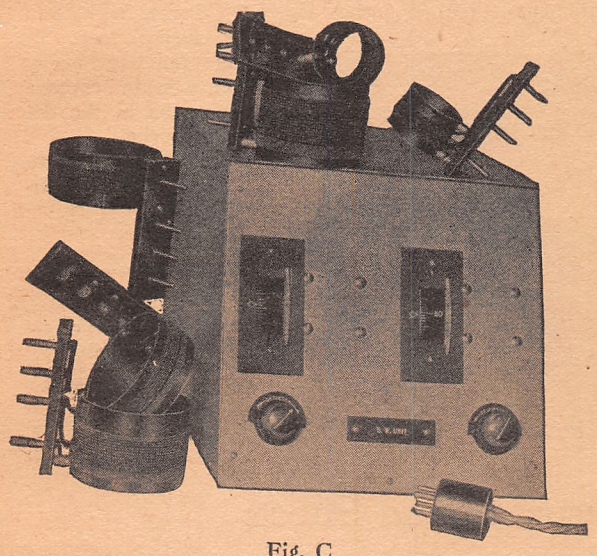
The circuit is not unusual, but the apparatus is designed for unusual efficiency; two tubes are required, the first a screen-grid (222) type, which is the amplifier of an untuned radio-frequency stage, and the second a general-purpose (201A) tube which is the detector. No audio stages are in-

cluded, since the unit was designed primarily for use with the separate amplifier unit produced by the same manufacturer. This does not mean, however, that it is not flexible; it may be used with equal efficiency with any other separate power amplifier, or the built-in amplifier of any standard receiving set. Phone reception is, of course, obtainable from the output of the unit without additional amplification.

Fig. 2

The circuit at the right is that of the Leutz receiver-adapter unit illustrated at the left. The untuned screen-grid circuit of the first stage amplifies, as well as stabilizes the unit.





At the left, the attractive external appearance of the unit in its aluminum cabinet. The additional plug-in coils give a range over a wide band.

Fig. C

Since the radio-frequency, screen-grid stage is "aperiodically" coupled to the antenna, an additional tuning control is not required for this stage, and operation is therefore simplified.

The detector is of the regenerative type, required by all short-wave sets, of whatever circuit; feed-back is controlled by the variable condenser (C6 in the accompanying schematic diagram of the circuit) in series with the plate or tickler coil. The plate circuit of the screen-grid stage ahead is isolated from the grid circuit of the detector by the grid condenser, to permit of the proper bias on the grid of this tube; and accordingly the grid leak is connected to a lead run directly from the grounded shield, instead of shunting the condenser.

The tuning dial controls the variable condenser C3, which has shunted across it the midget C4 to make the tuning both easier and finer. The second vernier drum actuates the regeneration condenser C6, which is therefore capable of the most exact adjustment. The midget condenser is controlled by one of the small panel knobs; and the other operates a rheostat when the unit is operated as a complete receiver, rather than as a converter for a broadcast set.

For the latter purpose, a plug is provided, to be used only when the unit draws current from a receiver. If it is connected externally to an amplifier, this plug is not used.

Fixed resistors (R1, R3, R5) control the filament circuits of the unit; R1 serves also to provide a bias for the grid of the screen-grid tube V1 by means of the drop through its resistance to ground, represented by the shield, which carries the negative filament connection and replaces that portion of the wiring.

A choke coil is placed in the lead to the plate of the screen-grid tube, further to concentrate the R.F. energy of the amplifier; and this lead, as well as the screen-grid voltage lead, are effectively by-passed.

Manufacturer: *C. R. Leutz, Inc., Long Island City, New York.*

Short-Wave Converter for Electrical Receivers

FOR some time past, the increasing interest in short-wave reception has caused broadcast listeners to demand equipment utilizing the audio amplification of their receivers. With this in mind, a midwest manufacturer is marketing a complete A.C. short-wave converter, designed for use with any A.C. electric receiver utilizing a 227-type detector tube. Because of the many intricacies involved, the unit has not been offered for sale in kit form; instead it is available as a finished product, as shown in the accompanying photographs.

The unit consists of a detector input stage particularly designed for A.C. operation; bearing in mind that the "hum" present in the average A.C. receiver becomes excessive when the tuned stages are operated close to the point of regeneration. The difficulty of "motorboating" is also removed by the use of a specially-designed filter system.

The converter is arranged for connection to the receiver proper, by means of a cable lead with a plug attachment, which is inserted into the receiver's detector socket. The tube previously employed as the detector, in the receiver, is removed from its socket and inserted into the socket provided for that purpose in the metal cabinet of the converter, in which the entire unit (with the exception of its plug-in coil) is housed. The coil mounting is located at the rear of the housing unit and is of the plug-

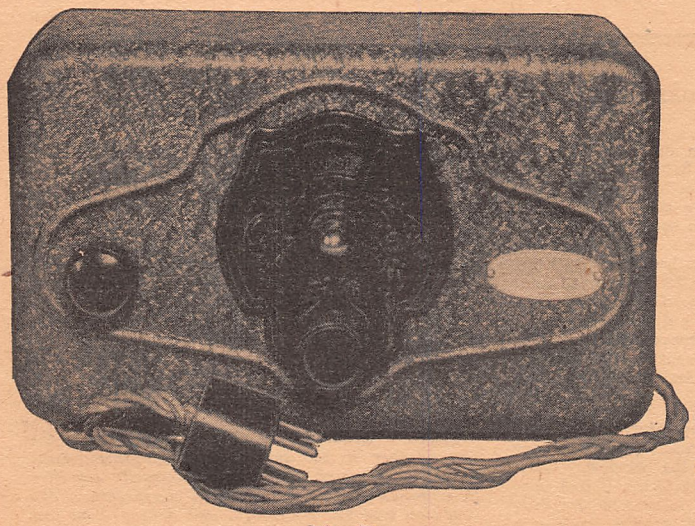


Fig. D

Front view of the Aero-Call short-wave converter.

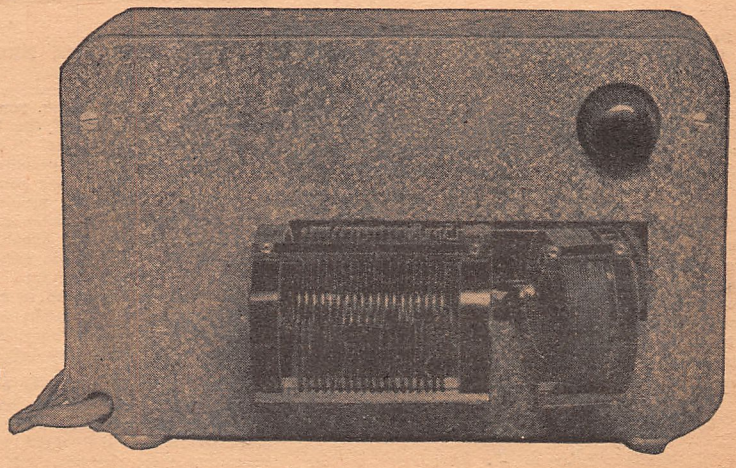


Fig. E

The rear view, showing position of the plug-in coil.

in type; affording interchangeable inductors covering the entire short-wave band.

The detector tube required by the converter is inserted into its socket after the rear cover is removed; this is accomplished by removing three screws, which are again replaced when the rear cover is in position. The front panel carries the tuning control (a single knob) and also the volume control; the rear panel only the coil mounting. The cable supplied with the unit includes all the leads required for connection, and terminates in a five-prong insert for the UY-type socket used by the detector tube in all A.C. sets.

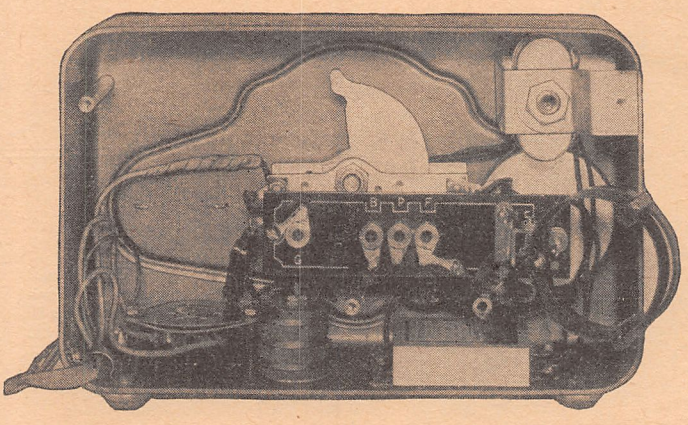
The coils supplied are classified as smallest, medium and largest; the wavelength band covered by the smallest is from 16.5 to 32 meters. The operating range of the medium coil is from 26.2 to 47.8 meters, and that of the largest coil from 46.7 to 90 meters.

The diameter of the winding in each case is 2 inches. The number of secondary turns used for the smallest coil is four; for the medium coil, nine; and for the largest, eighteen. By referring to the rear view of the converter, it may be seen that the primary coil is variable with respect to the secondary and tickler windings. The grid and plate windings are contained in one unit, the tickler being wound within the grid inductor.

The conventional tickler-feedback arrangement is used, with regeneration control in the form of a series resistance-capacity arrangement connected across the plate-filament circuit, between the battery end of the tickler coil and the cathode of the tube. A radio-frequency choke coil is provided in the plate return circuit. A "B" filter consisting of a resistor and a fixed condenser, which serves to minimize the possibility of "motorboating," is inserted in the "B+" circuit of the adapter plug; so that its resistance controls the value of plate voltages applied to the short-wave detector. The capacity in this filter serves as the required by-pass condenser.

A .00014-mf. tuning condenser is connected across the secondary. The entire unit is contained within a crackle-finish metal cabinet, 9 inches long, 5½ inches high, and 2½ inches deep. It will function only with a heated-cathode type tube in the detector socket.

Manufacturer: *Aero Products, Inc., Chicago, Ill.*



An internal view of the Aero-Call converter, showing the filter-resistor in the upper right-hand corner.

Radio "Mysteries" and Other Unusual Sound Effects

ODD occurrences in the nature of radio reproduction take place every now and again, and are a nine-day's-wonder in their immediate vicinity. They are reported in the daily press, and oftentimes may be explained quickly by radio engineers. In other cases, the phenomena, especially when reported by observers unfamiliar with radio, do not appear to be accounted for satisfactorily. Those which are best authenticated appear usually in the neighborhood of systems of pipes, wires, or metal structures which would provide a natural pick-up. The means of detection is usually the mystery; it may be presumed that it is necessarily a very delicate, carefully-balanced contact through which radio-frequency currents may flow in but one way. Sometimes there seems a total lack of any means of audio reproduction as well. The general subject was dealt with in the leading editorial of the January issue of RADIO NEWS, and a number of interesting manifestations were described at some length in the March issue. We add below a number of letters since received, dealing with sound reproduction, which was not in all cases associated with radio in the ordinary sense; but appeared to bear some similarity in its functioning to the radio "mysteries."—EDITOR.

"WIRELESS WIRE-TAPPING"

Editor, RADIO NEWS:

I have read your magazine ever since starting in the radio service game seven years ago, in which time I have run across some queer radio happenings. Here is one that seems more than a bit "mysterious." I happened, one day, to overhear a gentleman talking about a phone conversation he had picked up on his radio. The local end of the line was being used by a lady some half a mile away from him, and she was talking to her sister in Syracuse. To confirm his story, I called the lady in question who, though somewhat shocked, admitted that she had had a phone conversation with her sister at the stated time. The receiver used by the gentleman was a 3-tube Radiola. Now some experts claim that this is done through the ground on the water-pipes; but there is a river 500 feet wide dividing the two homes, and no water-pipes cross it. How do you account for this? His antenna is far from any phone wires, so he must have picked it out of the air.

JOE VINCENT,
Oswego, N. Y.

(It is rather difficult to make any definite statements unless one is actually present to make a thorough investigation. However, all facts point toward ordinary inductive pick-up.—EDITOR.)

A DX MYSTERY

Editor, RADIO NEWS:

In regard to the page of "mysteries" published in the January issue, here is one which you may add to your list. The aerial for our radio is strung between two chimneys. Last week we suddenly heard orchestral music emanating, it seemed, from the kettle. We turned on our set and found that the music coming out of the kettle was being radiated from WBZ. As soon as the radio was turned off, the kettle began playing; but as soon as the set was turned on, the "kettle music" stopped. The music, while not loud, could be heard distinctly and without distortion. There was about two inches of boiling water in the kettle, and the spout was touching a brick wall, at the end of the stove, through which the chimney runs. Although I have read of these radio phenomena before, I have not heard that they occur as far from the transmitter as we are located. (*About 40 miles from New York City*)

M. D. BURKE,
Mt. Kisco, N. Y.

(This, while similar to the bean story in our March issue, still leaves doubt as to the conditions prevalent in the kitchen, and as to the distribution of metal in the vicinity.—EDITOR.)

A TELEGRAPH BROADCASTER

Editor, RADIO NEWS:

I want to congratulate you on your February number as being one of the best I have seen in three years. The article, "Condensers and Their Uses in Radio," was especially good. I have run into a problem that I wish you could solve for me, if possible. While the problem in question does not pertain strictly to radio, it has to do with the transmission of sound. About 18 years ago, while employed on a railroad in eastern Oregon, my duties chanced to take me into a dispatching station one day, where I engaged in conversation with the telegraph operator. I might mention also that the weather that day was very clear, very cold and brisk; the light was very bright.

While I was talking to the operator, we suddenly heard what seemed to be human voices coming from the telegraph table near the window. Upon investigation we discovered that the sound was emanating from the telegraph relay and the little telegraph switchboard mounted on the wall over the table. We recognized the voice of the operator talking over the dispatcher's phone, about fifteen miles west of where we were located. This lasted several minutes and then faded away. I would like to know if this has ever been known to happen before. I have never been able to find another case like it on record.

JAMES L. WATSON,
Los Angeles, Calif.

(Mr. Watson heard the result of an action whose development has given us the loud speaker. The phenomena was simply inductive feed from the telephone wires to the telegraph wires—both running parallel to one another on the line construction. The magnets of the relay caused its armature to vibrate much like a telephone diaphragm, thus causing the sounds heard by him. The same effect is obtained by removing the paper diaphragm from a cone speaker; signals will be heard, although rather faintly.—EDITOR.)

THE RADIO SHARPENS EARS

Editor, RADIO NEWS:

Regarding your article, "Mysteries of Radio," in your January issue of RADIO NEWS: I have quite a "mystery" to add to those you listed. A few days ago I sat down before my short-wave receiver and, after some twisting of the dials, obtained no results. I tried shaking it gently, accompanied by a few choice words; this must have had the desired effect, for a slight hissing sound was heard in the phones. I then turned the dial in search of a carrier and found that, while I could not pick up a signal, I heard the voice of my brother, who at that moment was in the next room. The sound was distinct in the phones. Just then a boy called my brother and I heard him also although he was outdoors. This "reception" went on for five minutes and then suddenly stopped. I have not been able to duplicate it since. The set is a short-wave receiver I built a few months ago of old parts, and uses a variable tickler for regeneration control. Previous to this one I built three others, all using condenser control, but junked them because of body-capacity effects. However, this was before I read your article, "How to Succeed in Short-Wave Reception," in the December issue. This and other articles appearing in your magazine are very helpful to the beginner. Please publish more of them.

VIRGIL LINKE,
Manistee, Mich.

(Here it would appear that some contact in the set, whether in the tubes or outside them, must have been loosened until it was unusually sensitive to vibration—like a microphone's diaphragm. The condition was but temporary, and depended on this coincidence of circumstances.—EDITOR.)

(*Continued on page* 1048)

Increasing Selectivity in a Receiver

How Receivers in Operation at Present May Be Adapted to Modern Conditions of Reception, which Necessitate Ability to Tune out Everything Beyond a 10-kc. Channel

By C. Walter Palmer

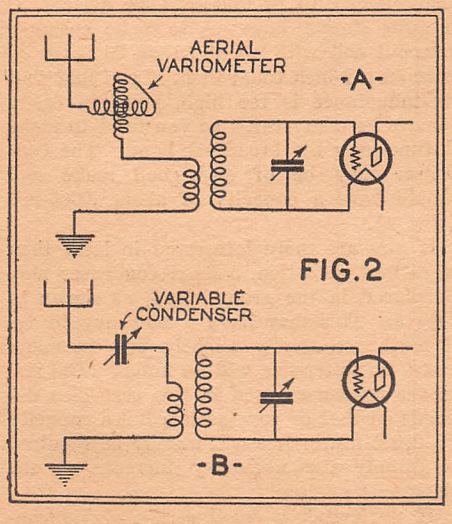
IT is hardly worth while to make any introductory remarks about the number of broadcast stations in the United States which are now operating on the wave-lengths between 200 and 550 meters. It is also of little avail to discuss here what might be done to relieve the condition. A great many articles have been written on this subject and many remedies and suggestions have been given; but it remains for "Old Father Time" to bring about the final satisfactory readjustment.

In the meantime, however, the problem remains unsolved and, to make radio reception more enjoyable (for those who own sets which were designed some time ago) some change or addition must be made in the receiver itself.

VOLUME OR SELECTIVITY

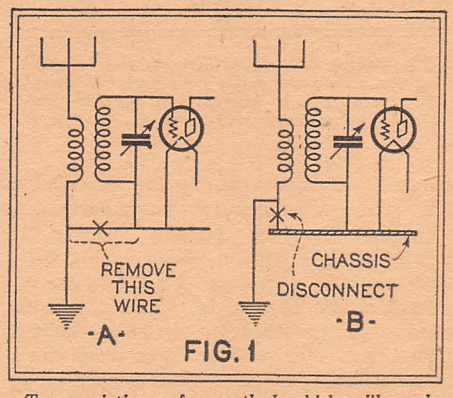
Off hand, one might think that the addition of an extra stage of radio-frequency amplification to a receiver would result in a great increase in the selectivity. Actually, however, this is not the case; but, on the contrary, the opposite is often true. In other words, if we have a receiver with two stages of radio-frequency amplification and we add a third, the sensitivity or distance-getting ability will be increased greatly; but we may find it more difficult to separate the powerful local stations.

The point is, that, if we have two receivers, equally selective, but one much more sensitive than the other, the latter receiver will appear to be much broader than the other, for reasons which have previously been often dealt with in this magazine (See page 826 of RADIO NEWS for March). If the controls are so adjusted that the outputs of the two sets are the same in volume, the ability to separate stations will be found about equal.



An antenna tuned by either a variometer or a variable condenser is not only more selective but also more sensitive to distant signals.

Also, if we have a very sensitive receiver in a central location, such as many in the mid-West, we will encounter interference from whistles produced by heterodynes of distant stations, as well as local interference. It is impossible to avoid these whistles, until some change is made in the station line-up.



Two variations of a method which will work in some cases; but not, as a rule, with electric sets commercially produced.

Although the following remarks may not solve the interference problems in many cases, they explain some of the troubles; and, by applying these principles, some readers may be able to receive all their locals without a background from other stations, and to tune "through" the locals for outside stations. If these general suggestions do not solve your interference problems or do not satisfy you, there are several other additions and changes that may be made to your set, to further reduce the possibility of encountering interference. But these will depend upon the peculiarities of its circuit and design.

Several solutions are given below; either one or more may be necessary to solve your problems. Nearly all of them involve the addition of a control; but you must realize that, even though radio is a wonderful art, it cannot be expected to achieve the impossible. Like everything else, it has its problems and drawbacks. If you desire extreme selectivity, you may have to sacrifice sensitivity; while, if you require great volume, you may have to sacrifice selectivity.

A COMPROMISE IS NECESSARY

This dilemma is one of the greatest problems encountered by manufacturers, who have to adapt their sets to meet any of a number of varying conditions. It is not possible to construct an *ideal* receiver—one embodying single control, extreme selectivity and unlimited sensitivity, as well as perfect quality. Any of you who have tried, again and again, to construct "that perfect" set know too well the problems that you are up against. The best that can be done is to strike a happy medium between extreme sensitivity, sharp selectivity and great volume. The introduction of some adjustable factor will allow an increase in any *one* of the three desirable qualities, where the conditions allow it.

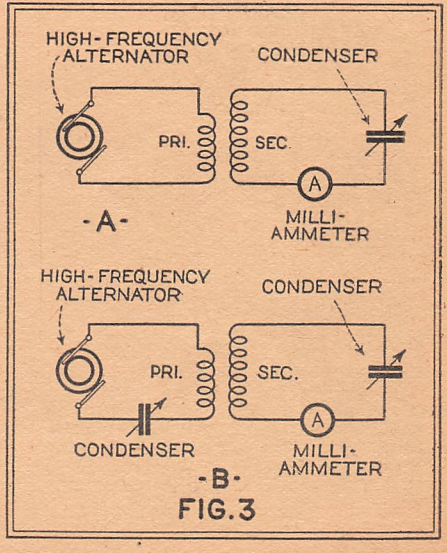
This principle is shown in the method of coupling the aerial adopted in most manufactured sets. Usually, either an "aperiodic" system ("untuned"—really a fixed-tune, outside the broadcast band) is used or, if the aerial circuit is variably tuned by a section of the gang condenser, a tapped inductor is used to compensate for the difference in the characteristics of different aerials.

With the above facts in mind, assuming that you have adjusted your set to the best of your ability, and also that you are not expecting too much from your set, let us see what additional changes can be made to cut out station interference.

HOW TO INCREASE SELECTIVITY

The first change is a simple one, in the wiring of the set itself. Many radio-frequency amplifiers have the filaments grounded, either by connecting one side of the filament circuit to the "Ground" binding post or by using a metal panel or sub-panel which carries the filament current. The change required is merely disconnecting the aerial primary winding from the "Ground" terminal or filament circuit, and connecting the ground wire directly to this loosened coil terminal. In other words, the filament wiring is no longer grounded directly. Fig. 1 shows how the change is made in a set which has its filament wiring connected to ground; Fig. 1A the corresponding change in a set which makes its filament connections to a metal sub-panel.

In many cases, you will find that this change will result in an increase in the



With given signal strength, the tuned primary at B transfers to the secondary more energy than will the untuned primary at A.

selectivity. However, it will sometimes cause your set to lose sensitivity or, if you are using a regenerative receiver, the regeneration may get out of control.

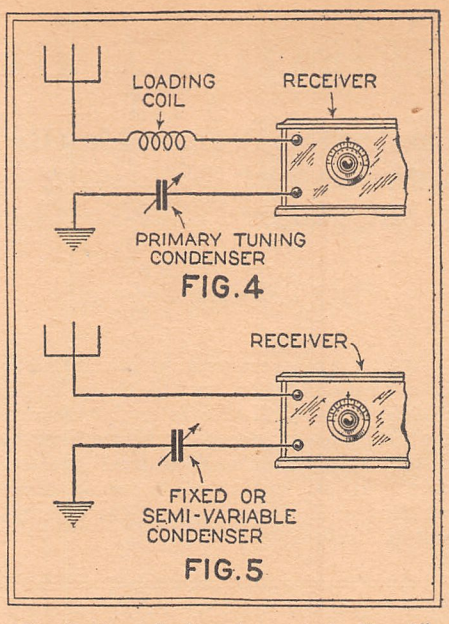
There is a type of set in common use which is not adaptable to this arrangement; that which has an *untuned* stage of radio-frequency amplification before the tuned stages. In this case, either a resistor or a choke coil is between ground and grid; since the choke or resistor completes the grid circuit, these circuits cannot be separated. In cases, also, where the power unit supplying the "B" current is grounded, the selectivity will not be improved by removing the ground connection from the filament; while a loud hum might be introduced in this way. In these cases, the change is not advisable; you must use your judgment in adopting the method most suited to your set.

TUNING THE AERIAL

Another simple method to which most receivers are adaptable, is to tune an antenna circuit to resonance with the incoming signal. Many of our veteran readers will remember the sets, popular some years ago, which used a *variometer* to tune the antenna. If you operated one of these at any time, you will undoubtedly recall the efficiency of this method of increasing selectivity; but for the benefit of our younger readers, we show how the variometer is connected (See Fig. 2A). Nearly all the receivers made commercially nowadays embody untuned aerial circuits; that is, the antenna circuit has no variable element, but consists only of the aerial and ground with a small fixed coil between them.

The reason, why this insensitive method of aerial coupling is used, is to bring about the elimination of one tuning control; this often proves quite satisfactory in cases where the selectivity need not be very great. It is also cheaper to use this design, rather than costly tuned systems with variable condensers and variable inductors; and, finally, it is easier to "log" stations.

For those who are not familiar with the variometer, we reproduce here a photograph of a very common type. The variometer is a continuously-variable inductance, in which *the inductance may be increased or decreased,* somewhat as the capacity is varied in a variable condenser. It is made up of two coils of approximately the same inductive value. One coil is wound outside its form and the other on the inside of its form (usually something like a hollow ball). The two coils are placed together; the one wound on its outside is placed within the other, to bring the fields of the two coils as close together as possible. The inner coil is mounted on a shaft so that it may be revolved, and in this way the two coils may be made either to *assist* or to *oppose* each other. With the two coils *assisting* each other, the inductance is at a maximum; while it is at a minimum when the two coils *oppose* each other. Different methods of winding and mounting the coils have been used, but the principle remains the same.



The loading coil above increases the "length" of the aerial; the series condenser "shortens" it. Sometimes the less efficient and less critical method below will serve the purpose.

The reader will be able to make a variometer, though not so highly efficient, by taking two pieces of thin tubing, one larger than the other, and winding equal-sized coils on the outsides of both. The smaller should be equipped with a shaft, and the larger with a bushing for panel mounting, like the familiar "three-circuit tuner." If the reader does not desire to make these coils, he can purchase them cheaply from most large radio dealers.

There are several things to be gained by the use in the antenna circuit of either a variometer or some other means of antenna tuning; such as the variable series condenser (Fig. 2B). Under the condition of *resonance* to the signal, the signal strength is greatest; or, in other words, the greatest amount of current is flowing through the antenna circuit.

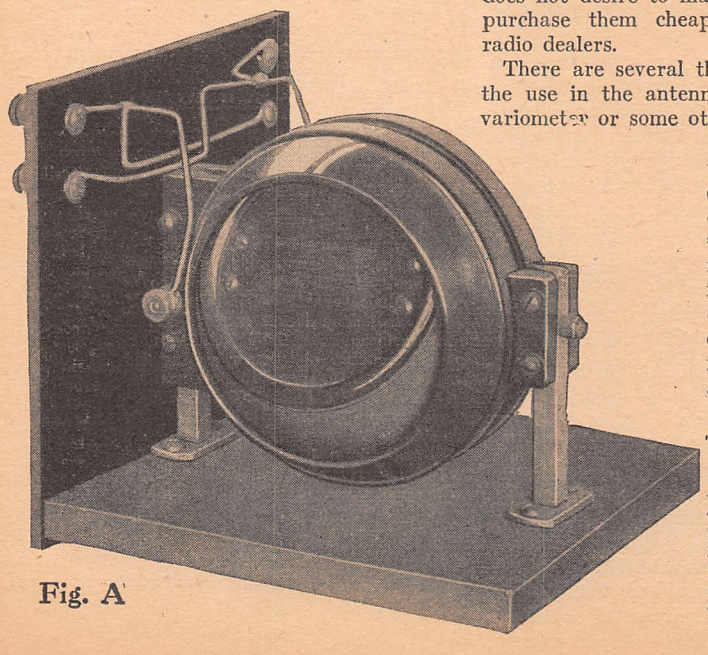


Fig. A

A specimen of the old-style "variometer" or variable inductor, of a type familiar to early-day set builders; sets were tuned by these before condensers came in style. The fixed coil is inside the larger ball, close to the other.

DOUBLE TUNING

But, when you tune both the primary and secondary together, it is possible to obtain a higher maximum. This may seem strange at first; how is it possible to have a value greater than maximum? To explain this, it is necessary to know what is meant by maximum. Fig. 3A is the schematic diagram of a tuned circuit; it consists of an A.C. generator supplying current to the *untuned primary* of a common tuned-radio-frequency transformer. The secondary coil is shunted by a variable condenser for tuning, and a milliammeter in series with the condenser measures the current. If we start the generator, current flows in the primary coil; this current has a certain definite frequency, that of the current supplied by the alternator. As we turn the plates of the variable condenser, the needle of the milliammeter in the secondary circuit shows an increasing reading as we near the frequency of the current in the primary. After we pass that value, the needle again returns toward its original position at zero. When the current indicated by the milliammeter showed its maximum value, the secondary was tuned to the frequency of the current generated by the high-frequency alternator (which may be a vacuum-tube oscillator or any other means of producing high-frequency currents).

Now, if we leave the secondary condenser at the point where the milliammeter indicates maximum current flow, and introduce a second variable condenser into the primary circuit (as shown in Fig. 3B); then slowly turn the plates of the primary condenser, a much higher maximum reading than before will be obtained. This indicates that, when the two circuits are in tune, the sensitivity of the stage is greater than when only one coil is used. Further than that, it is found that there is a great increase in the selectivity, because we have added an additional tuned circuit. There are various ways of bringing about this condition; one of them is to place a variometer in the aerial lead, as mentioned above.

SERIES CONDENSER

Another method of tuning the antenna is to place a variable condenser in the ground lead of the set and a "loading coil" in the aerial lead. It is not possible to say exactly how many turns will be required on this coil; as this depends on both the characteristics of the receiver that you are using and the capacity to ground of your aerial. It is quite simple, however, to make a simple solenoid coil with about 50 or 60 turns of wire on a 2-inch tube; then, if you find that its inductance is too high, you can easily remove as many turns as you need to make it tune over the broadcast band. The condenser may be of any good make and should have a capacity of about .0005-mf. (Fig. 4).

If you are more interested in local than in distant reception, a fixed condenser may be placed in the ground lead, as shown in Fig. 5. This may have a tendency to reduce the sensitivity slightly but, in many cases, no difference will be noted. The size of the condenser used in this case also depends on that of your aerial; but a capacity of .00025-mf. or less will usually be required to supply the necessary increase in the sharpness of tuning.

If preferred, a small semi-variable condenser, with a maximum capacity of some value higher than .00025-mf. and a minimum

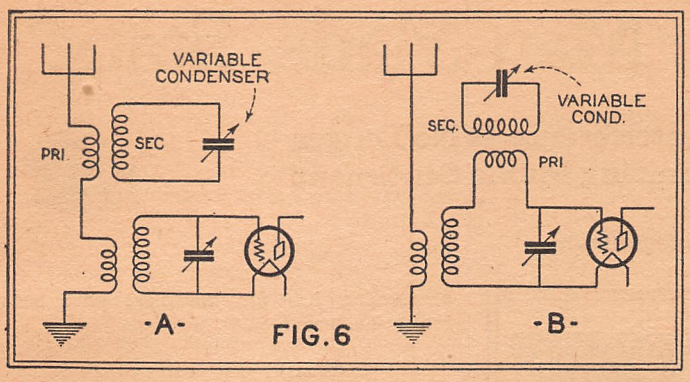


FIG. 6

Two of many ways to improve the selective powers of a set. See the "Constructor's" page also. Other applications are illustrated on pages 1023 *and* 1050.

of less than .0001-mf., may be used. In this way, the required capacity may be obtained very easily. The effect of this series condenser, without the inductance, is to reduce the effective capacity of the aerial; and of course, this usually causes a reduction in the apparent sensitivity, in the same way as a shorter aerial would.

There is no need for a continuously variable condenser in this series circuit, without the use of a loading coil; since the aerial circuit cannot be tuned to resonance with the incoming signal, anyway. The only advantage of using a variable condenser is that it becomes easier to obtain the capacity required to give the correct degree of selectivity.

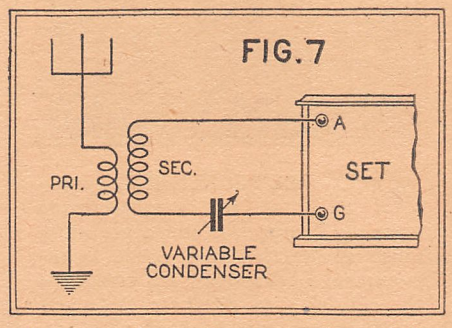
USING A WAVE TRAP

It is often found that the principal interference encountered in a receiver comes from one or more locals. When your set is located close to a powerful station, the signals from this transmitter will be broad enough to interfere with other stations. If the selectivity of the set is sufficiently great otherwise, the use of a device for reducing the strength of this station will often be sufficient to overcome all the difficulties with the set. A device operating in this way is known as a *wavetrap.*

Wavetraps are made in two types, the "rejector" and the "acceptor." The rejector is used, as described above, to reduce the volume of a powerful local station, so that it will not appear as a "background" to others. This type of trap circuit comprises a coil of wire and a variable condenser, connected in parallel and coupled to a smaller coil, which is in series with either the aerial lead or the grid circuit of the first tube; two methods of connecting the trap are shown at Fig. 6A and 6B. The secondary may be exactly similar to those of the R.F. coils in your set, and in this case, the condenser should have the same maximum capacity as the condensers in your set. However, any coil and condenser which will cover the same waveband may be used. The small coupling coil, which is the primary of the wavetrap, consists of a few turns (6 to 8) wrapped around the secondary; the coupling is close.

The operation of this unit is dependent on the absorption of signal current in a tuned circuit, which is exactly in resonance with the incoming signal frequency. To use the rejector trap, it is necessary merely to tune in the interfering station, and then to adjust the variable condenser of the trap till the circuit is in resonance with the station. As this condition is reached, the volume of the signal will drop off. When the set is tuned to other stations, the interfering local will be "conspicuous by its absence." In most cases, the reduction of the signal strength, when the set is again tuned to the interfering station, will not be sufficient to cause trouble; but, if the volume is not great enough, the wavetrap can be detuned and this will restore the station to its original volume. The expression, "rejector," is obvious; since you tune the trap to reject the undesirable station.

In some cases, a wavetrap of this type is not sufficient to cut out the interfering station, and it is then better to use the system shown in Fig. 7. This consists of a primary coil of about 10 turns of wire on a tube, say, 2½ inches in diameter. A secondary coil of the same dimensions as the coils in your set, is coupled to this primary coil, and a variable condenser of



A wavetrap is sometimes more efficient if its coil and condenser are in series. This is to be used especially to cut out a local station.

the size used in the set is connected as shown. This type of wavetrap is used in the same manner as the other "rejector" traps.

The "acceptor" wavetrap is merely a tuned circuit, inserted in the aerial lead in the manner suggested at the beginning of this discussion (Fig. 2) in order to tune the primary circuit to resonance with the secondary circuits. The two methods are often combined to give the combined action of tuning the aerial circuit and reducing the interference from one powerful station at the same time.

The wavetrap may be made or purchased as a separate unit, to be coupled externally to your set; or it may be inserted in the cabinet by fastening the condenser to the panel and the coil to a bracket at some point where there will be no coupling between the R.F. coils in the set and the wavetrap. It must be remembered, of course, that each tuned R.F. circuit is fundamentally a wavetrap; and that this device is merely the restoration of a control which has been deliberately omitted from the receiver.

SHIELDING

All of the recommendations made above assume that your set does not pick up signals when the aerial is disconnected; or at least that the volume is very much reduced when the aerial is disconnected. In case a local station is interfering very much, it is advisable first to disconnect the aerial and ground and notice just what effect is obtained. The suggestions made above apply only to the antenna circuit and, of course, the selectivity of a receiver will be very poor if signals are picked up in the succeeding coils and wiring. If the signals are picked up by the second or third tuning circuits, the first one has little or no effect on the tuning, and naturally, the selectivity will be poor.

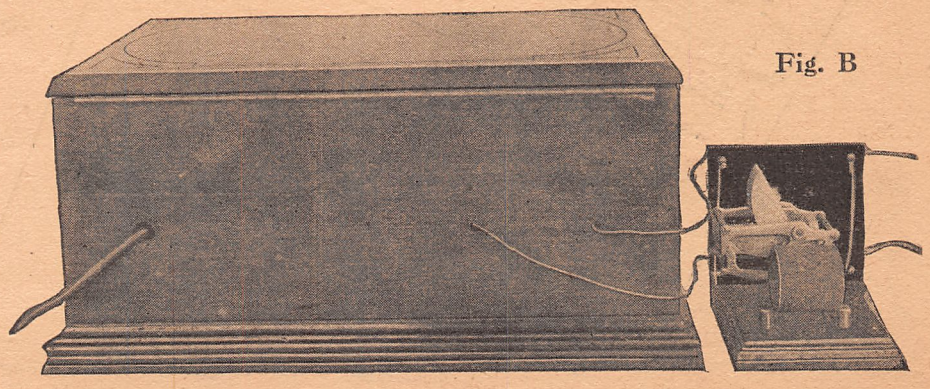
The most logical way of overcoming this trouble is to shield the entire receiver or place each succeeding stage, including the detector, in a separate shield. This will prevent any signals from being picked up in these circuits and will limit the input to the aerial. In most cases, this measure is sufficient to prevent two stations from being picked up at the same time and, if trouble is still encountered, one of the arrangements mentioned above will be sufficient.

In shielding a set, there are several points which must be taken into consideration. In the first place, the shielding should not come nearer to the coils than about 1½ inches; if it is closer than this, the capacity introduced (between the coil and shield) will lessen the wavelength range of the coil, and it will not cover the broadcast band. Also, this capacity will act as a by-pass for the signals, and the efficiency of the set will be reduced considerably.

In some cases, the complete set may be enclosed in a copper, brass or aluminum shield; or copper foil or sheet metal may be fastened around the inside of the cabinet. This will be sufficient to prevent a pick-up of signal energy by the coils of the set. The

(*Continued on page* 1040)

Fig. B



Whether acceptor or rejector, the wavetrap must be placed between receiver and antenna. If it is used to cut out strong local interference, the coils of the set must be shielded.

How to Deal With "Man-Made Static"

The Problem of Electrical Interference is No Longer Technical, But One of Organizing Public Sentiment

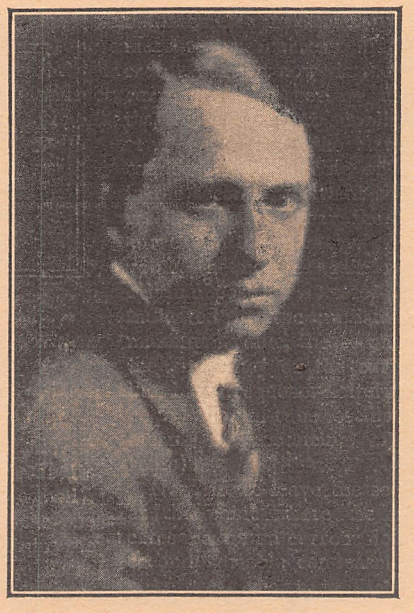
By Tobe Deutschmann

DURING the tremendous growth of the entire radio industry — which has been fighting to keep its production keyed up to a point where the market could be satisfactorily taken care of—time for the careful consideration of many accompanying problems has been lacking.

Radio can be likened to the automobile, only that it is a method of transporting *mental* objects by sound in the form of music and words. It has paralleled the development of the automobile industry, in which the production of cars for years required everyone's attention. The roads were pretty bad in the earliest days; in fact, have been good only in the last few years. Good roads followed the demand for them caused by a huge riding market.

Today we see radio sets in such numbers that the demand for better radio "roads" in the ether is starting to assume tremendous proportions. The new broadcast and other allocations are the result of this demand for better radio "roads." But still there are millions of imperfections in these new roads which must be ironed out before smooth, satisfying radio transportation can be achieved. These imperfections may be entitled "interference" or "man-made static."

Natural static offers its problems, but they are being overcome to a great degree by cleared channels and increased power. Local interference or man-made static is, however, a "horse of another color" and its overcoming has for the most part been totally neglected.



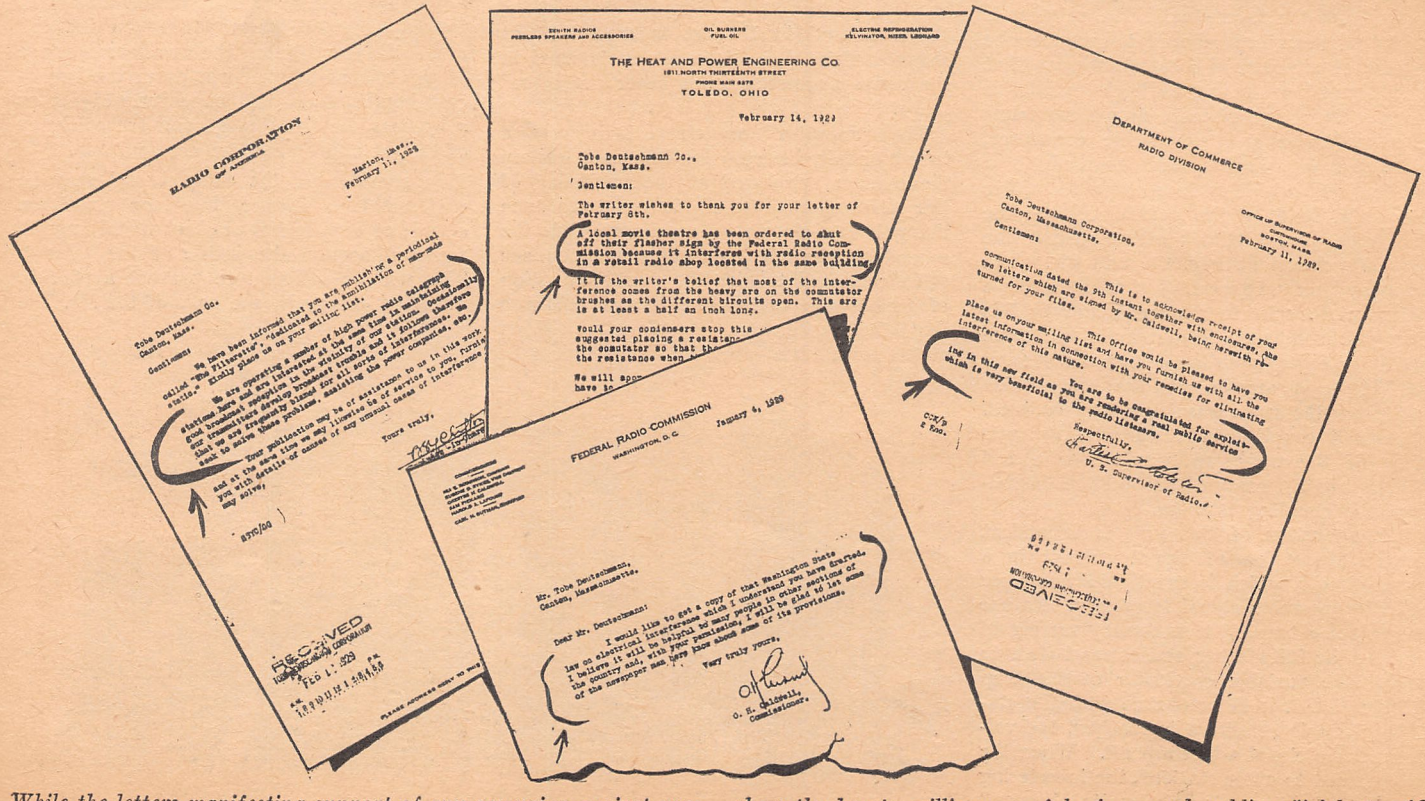
MR. DEUTSCHMANN, president of the manufacturing company bearing his name, has given much of his time and effort to the movement he describes. He points out the only way to eliminate the worst remaining menace to good radio reception.—EDITOR.

CLEARING OUT OBSTACLES

With ten million receivers in operation the listening public, well over its first thrill of just hearing music, has suddenly realized that many undesired noises are spoiling reception. Practically all of these are caused by local electrical machinery; such as motors, vacuum cleaners, washing machines, refrigerators, oil burners, hair dryers, fans, sign flashers, and all other electrical apparatus.

No one who has not lived with this problem night and day for a while—as we have—can appreciate the tremendous field of opportunity it offers. Every power and light company is eagerly seeking co-operation; as they want to sell electric current, and interfering machinery brings them constant complaints. Real estate operators cannot have satisfied tenants when their radio reception is spoiled by noises from oil burners, iceless refrigerators, ventilators and elevators.

That the Federal Radio Commission and other authorities, public service companies, and the like are highly in sympathy with the work which we are doing is evidenced by the hundreds of letters received daily. The Stromberg-Carlson, Atwater Kent, Zenith, and other prominent radio companies have all expressed willingness to take advantage of advisory engineering



While the letters manifesting support of any campaign against preventable interference are thousands, those reproduced above are to show the hearty willingness of business and public officials to aid so far as laws make it possible to protect radio listeners' rights.

service we have offered for their respective dealers. We have received as many as thirteen hundred letters a day from anxious set owners, who are troubled by this interference; and it has been necessary to engage sixteen stenographers in our office to handle this one department. One broadcast through a local (Boston) station brought 2,700 requests for assistance. This just illustrates the crying need for interference-prevention devices, and intelligent, truthful information.

As natural, when new devices and systems are announced, the public must be on their guard against the "cure-all" devices. We have already too many deluded buyers who have learned this after the "magic" cure-all device failed to do what the man said. Reputable manufacturers cannot afford to jeopardize their good names and they will not promise more than what the article will deliver. We do not believe it is yet possible, at this writing, to remove all interference by inserting a filter between the wall socket and the receiving set; because interference finds its way through many other entrances, even though the light lines may be principal carriers of interference.

Having been first in the field to recognize the need of interference filters, we have learned to appreciate the need of combating interference—not at the radio receiver, but at its source. While the technical problems of devising means to prevent the necessary equipment of modern industry and modern households have been great, they have been and are being met by engineering skill. It is no longer necessary that electrical apparatus of the thousand and one kinds now in daily use should be disturbing the radio atmosphere for miles about. The only thing that is necessary is to educate its owners to the fact that they must control the energy which would otherwise be radiated into the air; and to educate the radio public, and with them public officials and lawmaking bodies, to the fact that co-operation in clearing the air must be enforced.

THERE MUST BE A LAW

With the increasingly rapid growth of the electrical industry, it has become imperative that manufacture, distribution and use of electrical energy be carefully controlled, in order that electrical disturbances as affecting radio may not become so great that radio reception will be seriously interfered with, if not, as is now the case in some localities, completely ruined.

The proper time to correct this trouble is right now, before the increasing use of household and industrial electrical apparatus has become so great that regulation will work a hardship on both the manufacturers and users of electrical appliances.

Realizing the seriousness of this situation, most power and light companies throughout the country have established radio interference departments, with the result that reception today is marred but very slightly by electrical manufacturing and distributing systems; whereas, if these departments had not been established, in the majority of cases nearby radio reception would be impossible. In correcting troubles which cause electrical disturbances, the power companies have found that they helped, not only the listener, but also themselves; as many parasitic leaks, grounds, poor contacts and cases of poor installation have thus been discovered, which otherwise would not have been unsuspected.

So far, however, but little attention has been paid by the manufacturer of electrical devices to insuring the freedom of their apparatus from electrical disturbances as affecting radio reception. It is true that some of the larger manufacturers are studying this subject closely; but it is necessary to take further action towards the suppression of interference if any real good is to be accomplished at the present time. With this in mind, a model interference law is proposed.

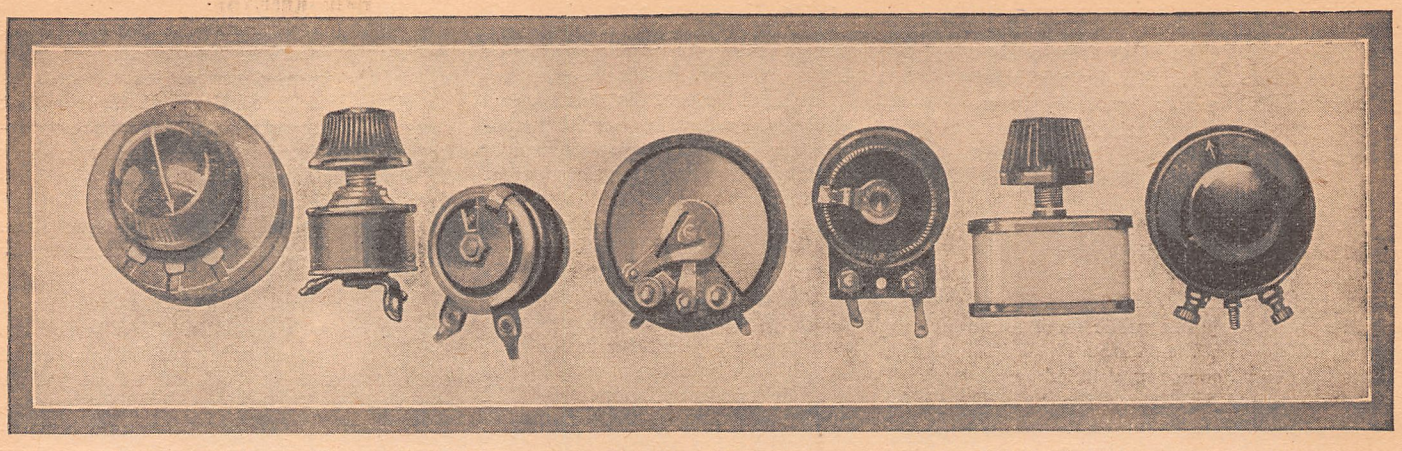
Upon first reading over the law, it will appear to be too drastic. This is not the case, however, as with proper study, all apparatus can be designed so as not to create electrical disturbances. Furthermore, it is now possible to obtain interference-suppression devices which, in the majority of cases, will entirely eliminate interference. Where this is not true, it has generally been found that, by making a slight change in the apparatus and at the same time applying an interference-suppression device, satisfactory results are secured.

To assist in complying with the law, an appendix has been added to the law as drafted, which should be of considerable help in determining what is causing interference and how it may be remedied.

In order not to work a hardship on the manufacturer, user or operator of the various types of apparatus which are causing interference, the law has been so drafted that the times at which the several sections become effective may be set so as to cause the least confusion and hardship. However, in order to secure immediate relief to the

(*Continued on page* 1041)

Large power plants may need a special system, but the needs of ordinary business are met by such filters as we see here. Many household appliances are made harmless by a small plug-in device like those in the centre.



The variable resistors above, suitable for volume controls, are (left to right) a Centralab wire-wound potentiometer; Clarostat (carbon-compression); Carter carbon-strip resistor; Centralab carbon-strip potentiometer; Electrad high-resistor; Bradleyohm (carbon-compression); and an old-style potentiometer which will adorn many junk-boxes. The potentiometer may be used either as voltage divider or plain variable resistor.

Choosing Between Volume-Control Methods

By Ashur van A. Sommers

It has been said that the method of controlling volume in a radio set can either "make" or "break" the set. At first glance, this appears to be a rather broad statement; but, on further consideration, it will be found that this is at least partly correct and, in many cases, entirely correct. For instance, if we refer to the methods used for controlling the volume in the average set several years ago, we find that they are considered entirely inadequate for present-day receivers, because the radio public has been educated to understand some of the causes of distortion in a set.

In Figs. 1 and 2 we find two common methods of volume control, most generally used in sets a few years ago. Fig. 1 shows the use of filament rheostats for controlling the filament temperature; this in itself is quite satisfactory, if care is taken to keep the tubes from being overloaded. If this reduction of the filament voltage is used for a volume control, however, there is a very great possibility of causing distortion; because the tubes will not carry as much plate current when the filaments are turned down, as when they are kept at the correct temperature. This effect is most evident when the radio-frequency and detector tubes are controlled by one rheostat.

Fig. 2 shows the use of a potentiometer R for oscillation control as well as volume control. As an *oscillation* control, the use of a potentiometer is satisfactory; providing the adjustable arm is kept on the side of the resistance wire which is connected to the negative filament terminal. Of course, the use of resistors in the grid wiring of sets is not to be advocated, unless correctly employed, and for this reason the use of the potentiometer in tuned-R.F. sets has been practically discontinued. Another drawback in using the potentiometer, either as a volume or oscillation control, is the large increase in the plate current caused when the movable arm of the potentiometer is moved to the positive side. A third reason is that broad tuning results from a positive bias on the grid.

OTHER DEVICES EMPLOYED

Both of the methods mentioned above have been largely discontinued, because of their inherent weaknesses; but inefficient volume controls are still being employed, and unbiased discussion of the various methods should help to straighten out this matter in the minds of radio builders. Probably the best way to show the relative advantages and disadvantages is to divide the different types of receivers into groups: we will refer first to direct-current (battery) sets using the standard tubes; secondly, to alternating-current sets; and thirdly, to the new screen-grid sets.

We may define the ideal volume control as that which will allow a gradual control of the receiver's volume from a whisper to the greatest possible amount of sound that the receiver can produce, without affecting the fidelity of reproduction. In controlling the volume, also, the tuning of the set must not be disturbed; since this would cause trouble in single-control sets. There are a number of otherwise suitable methods which cannot be used for this reason.

Practically, the volume control should be capable of reducing tube distortion when the set is turned down; since distortion is much more apparent on soft signals than on loud ones. Also, the set is often turned down solely to reduce the distortion, and, if the volume-control method used does not reduce the distortion more than the volume of music, it is not entirely suitable. By a method which will lower the input to the tubes which are most likely to be overloaded, distortion will be reduced considerably when the set is not operated at its greatest volume. The volume control must not introduce any distortion or noises of its own, and it must not change the characteristics of any of the apparatus in the set. There is one exception to this rule, which will be described later with the systems which are incorporated in the audio-frequency amplifier.

VOLUME CONTROL IN BATTERY SETS

Two methods which have fallen into disuse have been mentioned above; there are also several others which, though more in favor, are for one reason or another not quite satisfactory. A very common way to reduce the volume in a set is to place across the loud speaker a variable resistor of high value. The volume is controlled very satisfactorily in this manner; but, unfortunately, the *load on the tubes in the set is not lessened* when reduced volume is used and, because of this, the distortion is just as bad at a whisper as at a thunderous roar. This is not desirable, and a method of reducing the load on the tubes will permit the set to give better quality when the volume is reduced. This is particularly advantageous when local stations are being received, because of the overpowering signal strength.

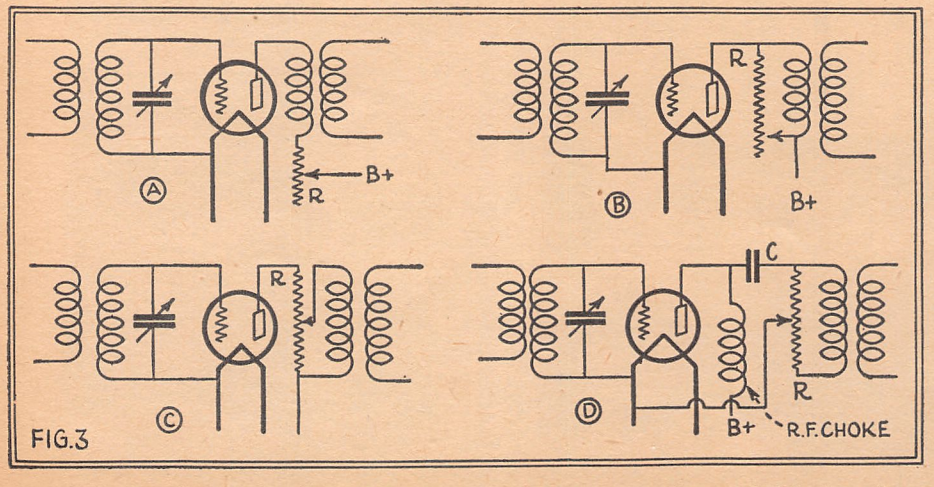
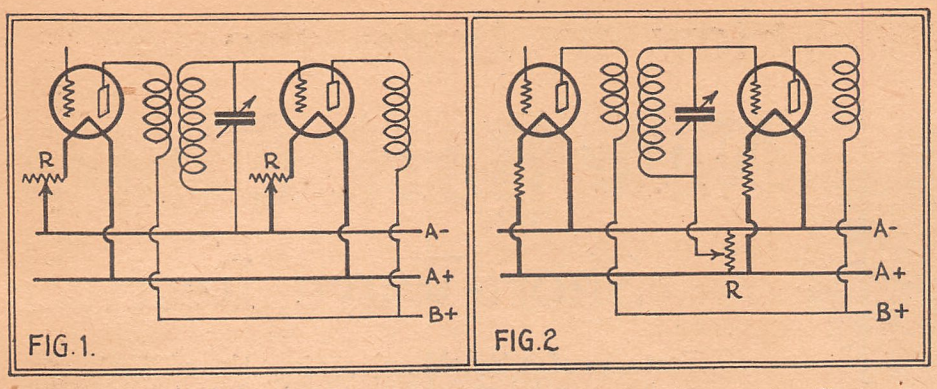


FIG.3

The first method (A) controls plate voltage and incidentally oscillation; the second (B) the voltage of the signal passed on. This and (C) are better adapted to small sets; that at (D) for the larger models of receivers, using power units, although it requires more components to construct the circuit.



Two old methods: Fig. 1, reducing filament emission by turning down the rheostats. Fig. 2, controlling bias of R.F. grid circuits by a potentiometer across the "A" battery. Neither is entirely satisfactory.

Another common method is to place a variable resistor across the primary of one of the audio-frequency transformers, usually the first. This method is slightly better than control at the speaker; but the detector and radio-frequency tubes are still operated at full load regardless of the volume. The use of a resistor across the transformer may also change its characteristics; although the change is often an advantageous one, especially with transformers which are "peaked" rather sharply, such as those designed some years ago. With more modern transformers, the change in the transformer characteristics may be a detriment rather than an asset; since it may change a good "characteristic" curve to a rather poor one. However other methods which will give control over the first tubes in the set, are more suitable.

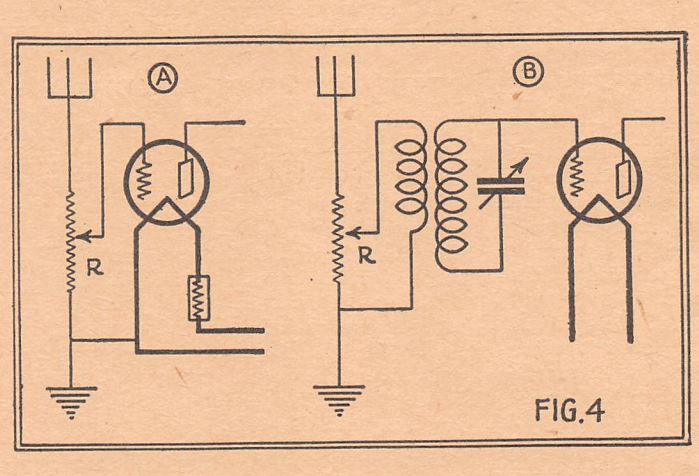
CATCH 'EM EARLY

Since the speaker and audio-amplifier methods of control are both applied too late, the logical conclusion is that a control either in the radio-frequency amplifier or in the aerial would be best. This leaves several methods, some of which are quite satisfactory and others less so. A variable resistor in series with the plate supply ("B"-battery lead) to the radio-frequency tubes is very often used and, in most sets, is quite satisfactory. This resistor serves also as an oscillation control and, in sets of only one or two stages, very good results can be obtained. This method is shown at A in Fig. 3, in which several other plate-voltage control methods are also illustrated; at B we have a high resistor in parallel with the primary of one of the radio-frequency transformers. This method is slightly better than the first for larger sets, but may cause a change in the tuning when its resistance is low. This is due to the fact that it practically short-circuits the tuned coil when the resistance is reduced; which reduces the primary's effective inductance, and causes also a change in the inductance of the tuned secondary. Such a result makes this method unsuitable for single-control sets, unless "trimming" condensers are used for matching the tuning condensers.

In the system shown at C this difficulty is avoided, but another encountered. If a "B" power unit is used, a variation in the setting will change the voltage applied to the plate; and this will also cause a difference in the voltages on the other tubes with corresponding complications. This is also true of using the series resistor as at A and, for that reason, this method is suitable only for small sets.

The method shown at D (Fig. 3) is the most suitable of the plate-circuit control methods, because it does not have any of the defects of the others. The choke coil maintains a constant potential, and the resistor reduces the volume without any alteration of the inductance in the primary coil.

When a set is used which is shielded, or for other reasons will not pick up signals without an aerial, the volume may be controlled in the aerial circuit; two methods are shown in Fig. 4. The first (at A) is a potentiometer, of about 10,000 ohms, directly across the grid circuit of the first radio frequency tube. This method reduces the number of tuning controls required in the set; but it also reduces the amplification, and for this reason is only suitable for large sets. The second (at B) allows the use of all tuning controls and is applicable to most sets; a resistor of about 25,000 ohms is used as shown. As mentioned above, a difficulty often encountered with controls of this type is due to the pick-up of strong signals in the coils and wiring of the amplifier and detector.



GRID RESISTOR CONTROLS

The final method of control in the radio-frequency amplifier is the grid circuit. Two methods of using this method of volume control are shown in Fig. 5; the first (A) is quite satisfactory if single-dial tuning is not used. However, it is not entirely suitable if the tuning controls are ganged together, because of the detuning effect; but this detuning can be overcome by using the system shown at B. The disadvantage of this method is the effect on the selectivity; when the resistance is reduced, the selectivity is ruined.

The resistor used in the grid control must have a very high maximum value, so that the amplification is not reduced on the maximum setting; one of about 500,000 to 1,000,000 ohms is required for this purpose. If the grid control is placed in the last stage of radio-frequency amplification, the detector will not be overloaded and the volume will be controlled even though the set may operate with the aerial disconnected.

To sum up the best methods of controlling volume in a battery-operated set, we find that the radio-frequency and aerial control methods afford the most advantages and fewest disadvantages. Of these, the ones shown as 3D, 4B and 5A are applicable to most sets.

The aerial resistor is highly satisfactory, from the standpoint of quality solely.

VOLUME CONTROL IN A.C. SETS

The problem of controlling volume in alternating-current operated sets using their special tubes, is quite different from that encountered in battery sets. In order to simplify the discussion, it is best to divide the sets into two classes; first, those using the 'heater-" (227-, etc.) type tubes and, secondly, those using the direct-to-"filament-(226-, etc.) type" tubes in the amplifier sockets. In sets using the heater tubes in all stages (except the last audio-frequency or "power") most of the systems of volume control above outlined for battery sets are satisfactory. In order to keep the hum at a minimum, however, it is advisable to use some system which will not disturb the plate and grid voltages.

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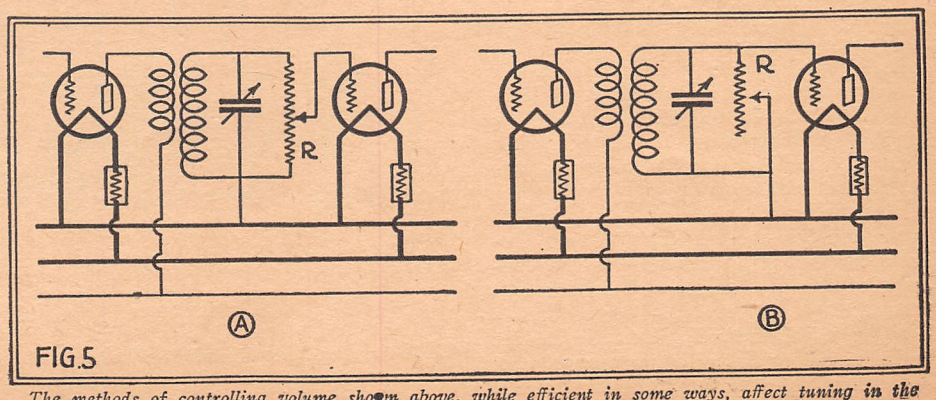
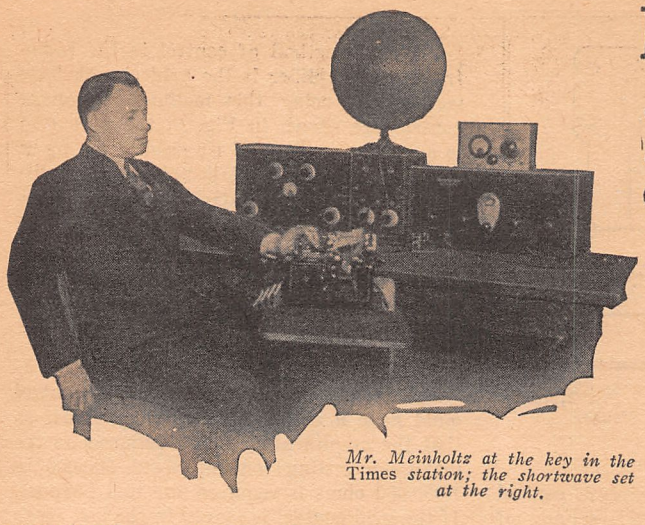


The methods of controlling volume shown above, while efficient in some ways, affect tuning in the circuit shown at A, and selectivity in that at B. High resistance is necessary here.



Mr. Meinholtz at the key in the Times station; the shortwave set at the right.

How to Build the New York Times Short-Wave Receiver

Details of a Set Duplicating that Used to Maintain Communication with the Byrd Expedition in the Antarctic

By Fred E. Meinholtz

EVER since the inception of our regular transmission schedule on short waves with the Byrd Expedition in the Antarctic, we have received numerous requests from radio fans asking for the circuit diagram, constructional details and kindred information on the short-wave receiver used by us at the radio station of the *New York Times*. By means of this receiver we have been, and still are at this writing, in nightly communication with the *City of New York* (Byrd's steamship, which conveyed his party to the Antarctic), and quite often "take" from them press dispatches totalling 3,000 to 4,000 words per night. The publicity accorded this reception (an example of which was illustrated in the April issue of RADIO NEWS) shows the interest that the success of this work has aroused. It might seem rather unusual that the station which operates so consistently over this great distance should be located in the heart of New York City, amid its towering steel buildings; but this is the case, as the reader will remember from last month.

The set described here is almost identical mechanically, as well as electrically, with the receiver we are using daily. The differences are all of slight importance and made only to facilitate the construction of the set by fans who are so situated (geographically and otherwise) that they cannot obtain the special apparatus which we originally used. These differences will have no effect on the operation of the receiver, however; since the substituted parts are fully as efficient as those in the original. To explain the changes made, we may mention that the original receiver uses a panel nine inches high and, of course, this size is rather difficult to obtain in most localities, as well as much more expensive than the standard panels.

A SINGLE-CONTROL SET

Although the circuit of the set is not unusual, there are several departures from the common design of short-wave receivers. In the first place, *the two tuning condensers are ganged together;* which makes the change from one wave to another more easy. We placed a midget condenser across that section of the tuning condenser which controls the aerial coupling coil; so that fine tuning can be accomplished by thus compensating for any difference in the constants of the two circuits. This arrangement of the tuning controls is more flexible than the usual method; since the midget condenser allows closer tuning when the set has been adjusted to the approximate wave desired.

The remarkable results obtained with our receiver are attributed partly to the use of the best obtainable apparatus, as well as the use of correctly designed shielding in the radio-frequency amplifier and detector stages, and the complete isolation of all circuits by using by-pass condensers and chokes wherever it was found necessary. In building the receiver we were very careful to avoid any body capacity which would cause a change in the tuning since, for communication purposes, it is necessary to have a receiver which will maintain its tuning exactly for long periods of time. Otherwise, the reception might "fade out" at a critical time and cause a serious delay in the communication. It was for this reason also that a second receiver (mentioned in the article in the April issue) was installed in the writer's house. It was found, after shielding the lead from the plate of the radio-frequency tube, and by using box shields for the detector and screen-grid circuits, that there was absolutely no difference in the tuning when the operator's hand was removed from the dials.

Another point which adds to the efficiency of the receiver is the use of a tuned grid circuit for the R.F. stage rather than the untuned inputs that are found in most of the screen-grid short-wave sets at this time. Of course, the introduction of tuning at this point makes the set somewhat more expensive to build and more complicated to tune but, for our purposes, these were comparatively insignificant when compared with results. Because of the varying conditions encountered, a two-stage audio-frequency amplifier was included. In cases where the station "worked" is very far away, as in the case of the *City of New York*, or when the fading is very bad, the second stage of audio-frequency amplification comes in very handy. In fact, it would be entirely impossible to copy the messages in some cases without this stage. For the reception of short-wave broadcasting, when loud-speaker volume is desired, the second audio stage is essential also, because one stage is insufficient except on comparatively nearby stations.

PARTS REQUIRED

The tuning range of the set of coils employed in the receiver is between 15 and 107 meters, while a larger coil which tunes up to 215 meters is available. The three coils supplied for the original set will be described later.

A complete list of parts, necessary for building the *New York Times* short-wave receiver, follows. The experienced constructor may use his discretion in choosing

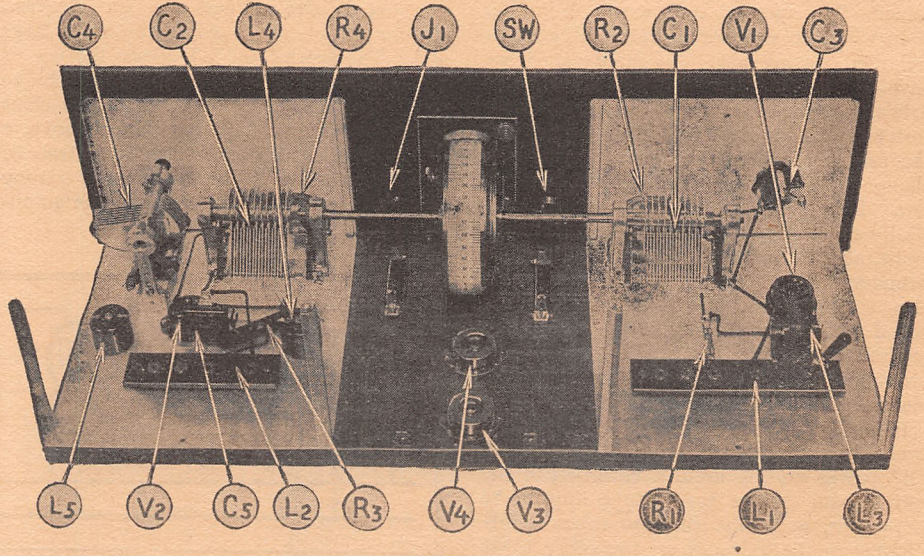


Fig. B

The receiver partially assembled to show placement. The coupling shaft should not, in actual construction, be inserted until the shields are mounted. A dial of this type, instead of that in the original model, is used for greater ease of construction. Be careful when mounting V3 and V4 to leave ample play for the dial and room for the audio transformers.

components; but those who wish to duplicate the model illustrated in these pages (which was constructed in the RADIO NEWS *Laboratory*) may find the list of manufacturers of assistance.

Two National double-spaced variable condensers, .000125-mf., type EC-125 (C1, C2);

One Hammarlund midget variable condenser, for trimming, .0001-mf., type MC-23 (C3);

One National variable condenser, for regeneration control, .00025-mf., type ET-250 (C4);

One Carter molded-bakelite fixed condenser, .0001-mf. (C5);

Five Acme "Parvolt" by-pass condensers, 0.1-mf., type A (C6, C7, C8, C9, C10);

Two sets of Hammarlund short-wave coils and bases (three coils to each set) type SWT3 and SWC 3 (L1, L2);

One Carter 10-ohm fixed resistor for screen-grid tube, type H-10 (R1);

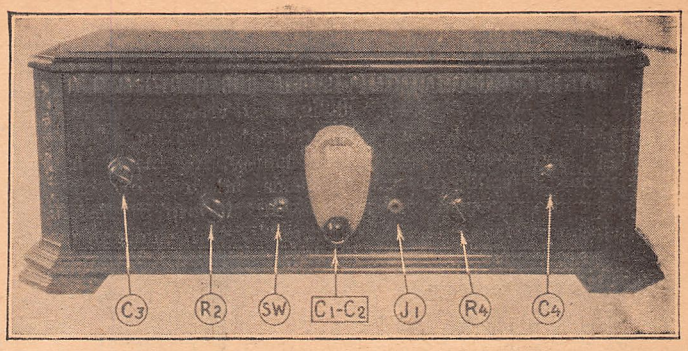


Fig. A

A standard broadcast-receiver cabinet is used for the constructor's convenience. The jack J1 is needed for phones.

Two Carter filament rheostats, 25-ohm, type M-25 (R2, R4);

One Durham grid leak, 5-megohm (R3);

Two Amperites, 1A type (R5, R6);

One Transformer Co. of America audio-frequency transformer, type 512 (T1);

One Transformer Co. of America audio-frequency transformer, type 611 (T2);

Three Silver-Marshall radio-frequency choke coils, 2½-millihenry, type 275 (L3, L4, L5);

Four Pilot UX-type tube sockets;

Two Hammarlund aluminum box shields, 7¾ x 8¼ x 5¼ inches, type HQS-1;

One Carter filament switch, type 123 (SW);

One Carter single-circuit jack (J1);

One National illuminated drum dial, type VF;

One grid-leak mounting;

One ¼-inch brass rod, 15½ inches long;

One Insuline panel, 7 x 24 x 3/16 inches (to be drilled as in Fig. 3);

One piece of 3/16-inch insulation, 7⅛ x 2¼ inches;

Ten X-L push-type binding posts, with insulated tops;

Two brass angles for mounting the binding post strip;

One Cunningham CX-322 screen grid tube (V1);

Two Cunningham CX-301A tubes (V2, V3);

One Cunningham CX 371A power tube (V4). (The use of a power tube is optional; either a 371A, 312A or 301A tube may be used. Note the proper grid and plate voltages for these tubes; this information can be found on the data sheet accompanying each tube.)

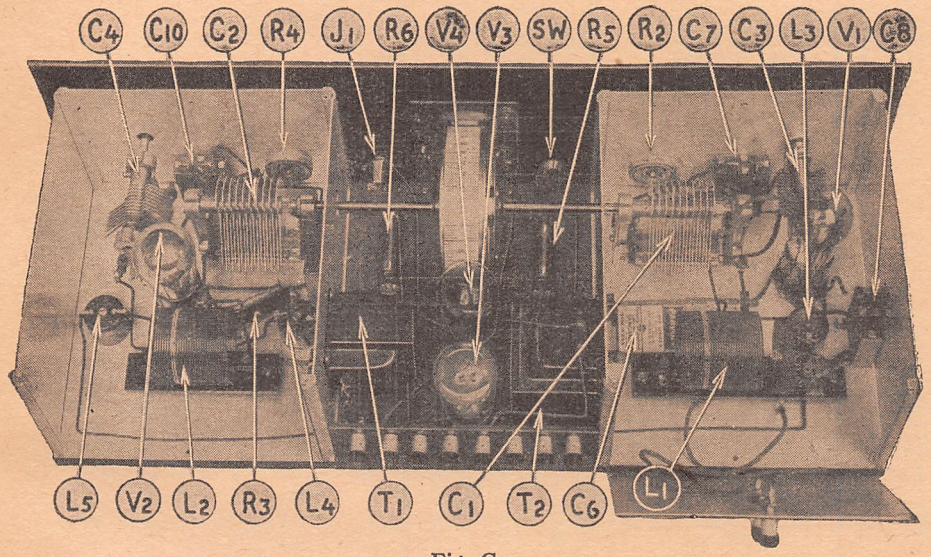


Fig. C

The complete receiver, with the tops and backs of the shield removed to show the simplicity and roominess. The audio transformers are mounted to the shield sides before placing the latter. A small test clip makes an effective contact with the screen-grid of V1; aerial and ground posts are mounted on the back of the first shield.

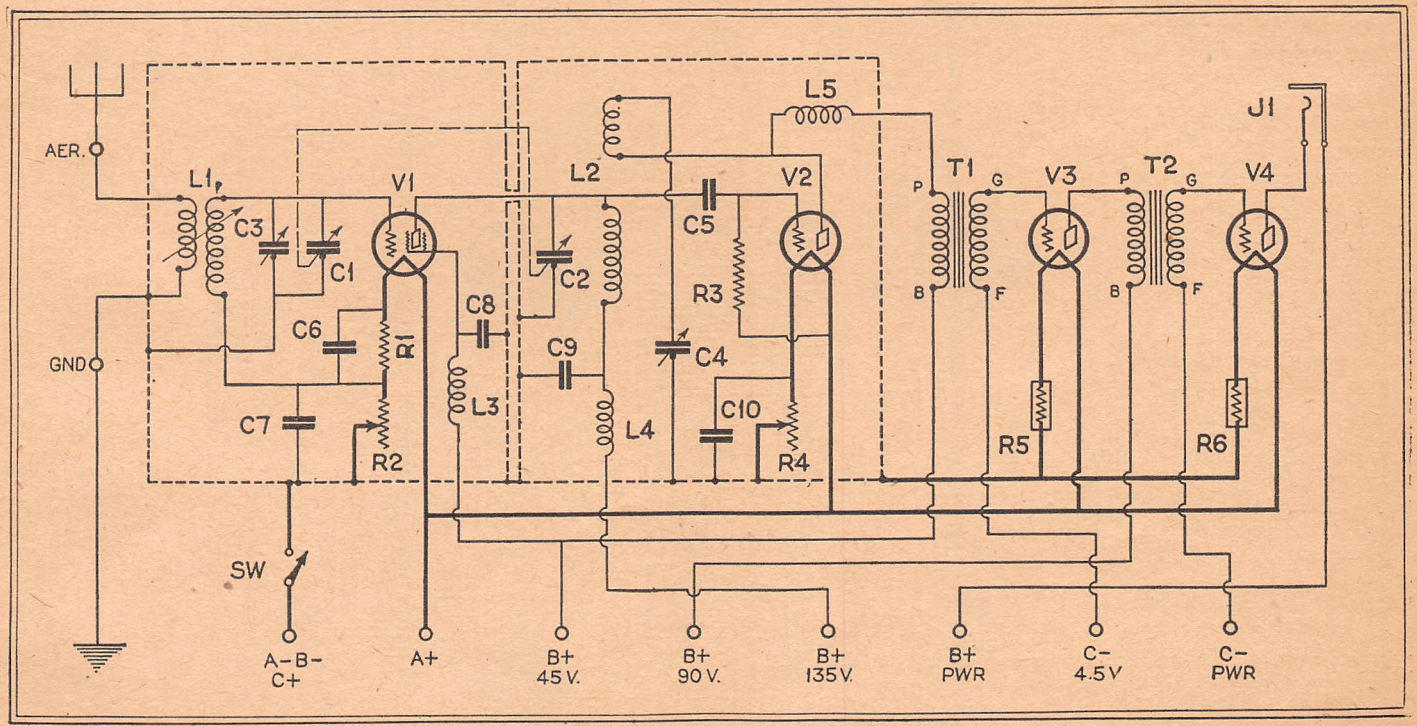


Fig. 1

The schematic wiring diagram of the New York Times *short-wave receiver. This is the same as that of the model illustrated above, which differs only in a few mechanical details. The pictorial layout of the set appears on the next page.*

One roll of Acme "Celatsite" hook-up wire;

One length of Acme shielded wire, 15 inches;

One test clip for top of screen-grid tube;

One wooden sub-base, 22½ x 8¾ x ¾ inches;

Miscellaneous screws, soldering lugs, etc.

ROOMY SHIELDING

The shields which we use for the radio-frequency amplifier and the detector in this receiver are somewhat larger than those usually amployed for shielding individual stages of a set. They measure 7¾ inches long, 8¼ inches wide and 5¼ inches high, and are made of aluminum about 1/16-inch thick. The manufactured shields come equipped with a partition, so that the shield can be used for two stages in a receiver. In this case, however, the partition is removed, since all the room in the shield is required for a single stage.

The shields may be either purchased for the purpose, or made at home. If they are home constructed, there are two procedures which may be followed. The first is to obtain a long strip of copper or aluminum for the sides and bend it over a straightedge (such as the edge of a work bench) and then fasten flat pieces on the top and bottom to complete the box. The second is to obtain slotted aluminum corner pieces from a hardware store or metal worker; such pieces are made in different forms for different purposes. The type desired is square in cross section and machined with two slots on adjacent sides. The sides of the shield are set into these slots. The first method is easier; but the second is to be preferred if the required corner pieces are obtainable, as they strengthen the assembly greatly.

CONSTRUCTIONAL WORK

The first step in the construction of the receiver, after the shields have been procured, is to fasten the drum dial and the shield cans in position on the baseboard. The shields are placed at the ends of the baseboard and the dial in the center. The positions of the apparatus, in the shields and in the audio amplifier section between the shields, are shown in the pictorial drawing and the photographs reproduced. This layout should be followed exactly; since any change in the positions of the parts will undoubtedly cause a change in the operation of the set. The inner walls of the two shields are drilled with ½-inch holes for the shaft of the condensers. The two other condenser controls are mounted on the front panel. In mounting the regeneration condenser, you

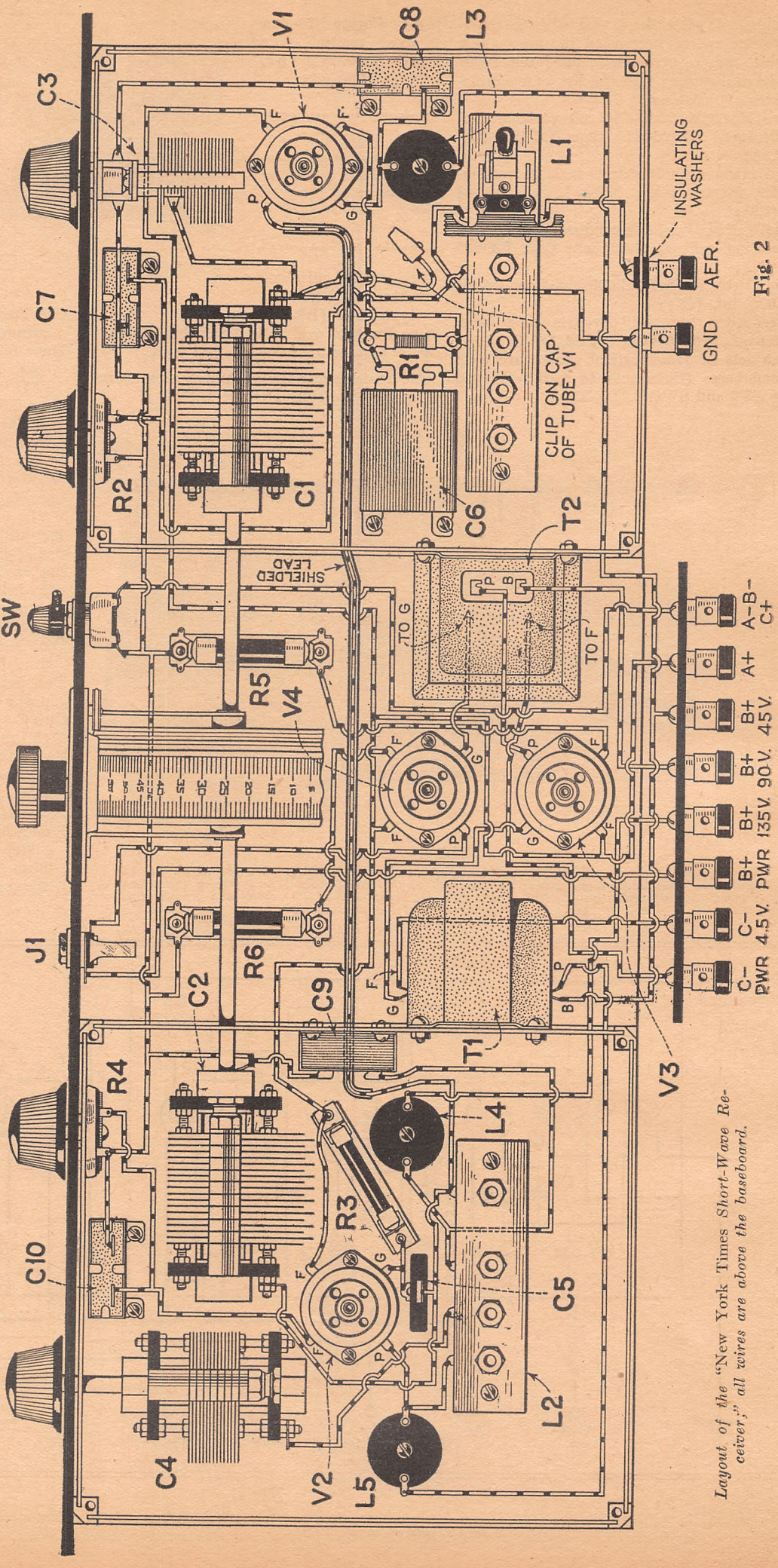


Fig. 2. *Layout of the "New York Times Short-Wave Receiver," all wires are above the baseboard.*

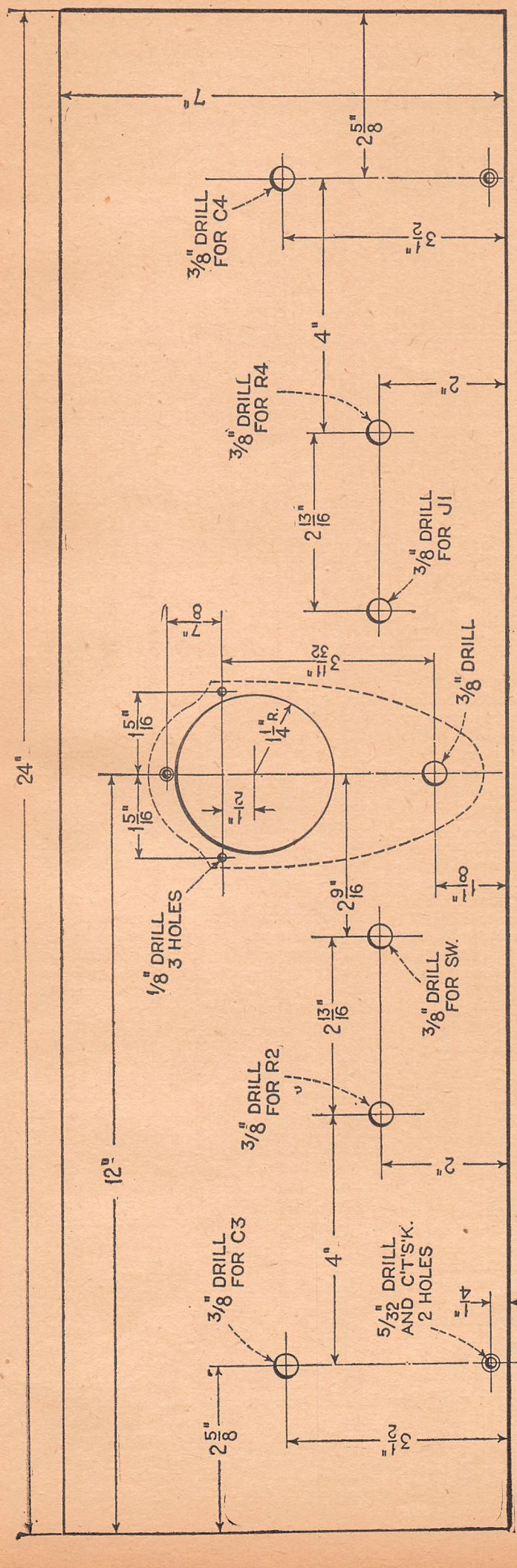


Fig. 3

The drilling details of the panel and the binding-post strip required for the "New York Times" short-wave receiver. It will be seen that no template is required; the panel has but twelve holes in addition to the dial window. If the constructor has not a special cutter, the old method of drilling as many holes as possible in the penciled circle, and then tapping out the disc with the butt of the screwdriver will serve well. A ¼-inch drill is suitable for the purposes. Leave as little space as possible between the holes, to minimize the risk of cracking the panel.

In Fig. 2, on the opposite page, the components are represented slightly larger than their proportionate size, so that the apparent space between them is diminished. As the photos show, however, the actual placement is quite roomy; diminishing the capacity effects which are important at high frequencies. It will be noticed, also, that to make connections clear, the binding-post strip is shown separated from the receiver. Care should be taken by the constructor to see that the rotor plates of C4 clear the shield safely when they are open, to avoid a short-circuit.

~DETAIL OF BINDING POST STRIP~

must take care to insulate it from the shielding; as any contact would cause a short circuit in the plate circuit. If the specified condenser is used it may be mounted on the bottom of the shield. A ½-inch hole in the front of the shield is sufficient to prevent the shaft from touching it.

All the apparatus may be mounted and wired before the panel is drilled and fastened in place, since the drum dial is mounted on the baseboard. You will find this very convenient in wiring the set, especially in places that would otherwise be inaccessible. The audio-frequency transformers are mounted on the sides of the shields, to conserve space and also to provide a convenient ground for the cases of these transformers. The only other peculiar point in the construction of the set is the use of a shielded wire for the plate lead from the screen-grid R.F. tube. This was done because of the possibility of a feed-back occurring at this point. By shielding this wire, we entirely eliminated this possibility.

A jack is used for the loudspeaker connections, for two reasons. In the first place, it is necessary to tune a short-wave set with phones. This is due to the extreme sharpness of the tuning, especially on distant stations. In the second, the set was designed for commercial purposes, and phones are used exclusively for copying messages.

THE COILS

The coils used in the receiver are manufactured and sold in complete sets covering three wavebands, from 15 to 107 meters. They are of the plug-in type, the receptacle having four jacks, similar in construction to phone-tip jacks, but somewhat larger. One of the coil mountings is equipped with a primary coil, fastened on a hinge, so that the coupling can be varied. This coil contains 6 turns of No. 18 double-silk-covered wire, spaced at a distance equal to the thickness of the wire. The form on which the coil is wound is of celluloid; the wire is wound on, and then the celluloid is so treated that the wire is firmly fastened to the form. The latter is 1⅞ inches in diameter. In constructing coils at home, a similar method of mounting may be employed, or the coils may be wound on cardboard (if treated against moisture) or other suitable material.

The smallest of the plug-in coils has a secondary of four turns, and a tickler or plate coil of three turns. No. 18 D.S.C. wire is employed for the coils

(*Continued on page* 1046)

A "Hartley" R. F. Broadcast Receiver

By B. B. Bryant

LONG before the day of the present multitude of broadcast stations—and of single-control sets with six to ten tubes—the regenerative receiver was in its heyday of popularity. That popularity was not altogether unjustified, as many users to this day will testify. The "single-circuit" regenerative receiver has a fairly consistent range of a thousand miles but, although sensitive, it is not sufficiently selective for general use today. Fair selectivity is obtained when the single-circuit (in reality a double circuit) is modified to a "three-circuit" receiver. Naturally, this is at the expense of the sensitivity, which is decreased to a range less than half that of the former circuit; its degree is dependent upon that of the coupling of the pick-up or antenna system to the detector circuit.

THE OLD FAULT

There are many arrangements of regenerative sets, which employ various slight modifications of a few fundamental circuits. The "Hartley" is one of the best known of the basic circuits, and practically all others are merely variations of the application of the same principle. In its simplest form, it is *conductively* coupled between input and output: that is, the returns of both grid and plate coils are connected directly at one point, forming one continuous secondary winding. The plate supply ("B" battery) is connected in a suitable manner to the outer terminal of the plate coil; and the outer terminal of the grid coil is connected through the grid leak and condenser (if the grid-current method of detection is used) to the grid of the regenerative detector. The inner terminals of both grid and plate coils are connected to "A+" if the leak-condenser system is used (unless with a 200A-type detector); otherwise to "A—."

WHILE the simpler sets which are published in this magazine are intended especially to give the beginner an opportunity to develop his skill at little cost, they are not to be despised by the more advanced set builders who are not always at work on ten-tubers. The enthusiastic reports of constructors of previous small sets leads us to offer this compact, efficient set for their use. It is adaptable to dry-cell operation and has high portability, though it is inexpensive to build and use.

If connected directly to the antenna, either a single- or a three-circuit receiver becomes a transmitter when allowed improperly to oscillate. This fact explains a good deal of the interference suffered by set owners; oscillating sets cause howls, squeals and cross-talk in neighboring loud speakers, and have therefore earned the descriptive title of "bloopers." The radiation from a single-tube receiver can be detected, even on the broadcast band, for many miles with a sensitive set; and in the early days, when crystal sets were in the majority, it was not uncommon for the owner of one to claim DX reception when, as a matter of fact, he had picked up only the signal re-radiated by a "blooper" which might be even a mile distant.

THE CURE

Many methods have been devised to prevent radiation from such receivers; the most effective is the use of a so-called "dummy" or "blocking" stage. Notwithstanding the name, which might lead to the idea that this stage is useless except to prevent radiation, it actually does amplify the signal and therefore increases sensitivity in a three-circuit regenerative receiver. The result is that this combination gives sensitivity ordinarily equal to that of the old single-circuit hook-up; and the necessary outlay for such an addition to the set is therefore justified by the improvement. The parts required for one more stage, untuned, as in the receiver illustrated here, are inexpensive and, when tubes of good quality are low in price, there is no reason to balk at the use of another—as there would have been in the days when tubes of the 201-type cost $6.50 apiece and were hard to get at that price. The only real objection a constructor can urge is that the consumption of current is increased; but this is more than compensated by the improvement in his reception, as well as the peace of mind of his neighbors.

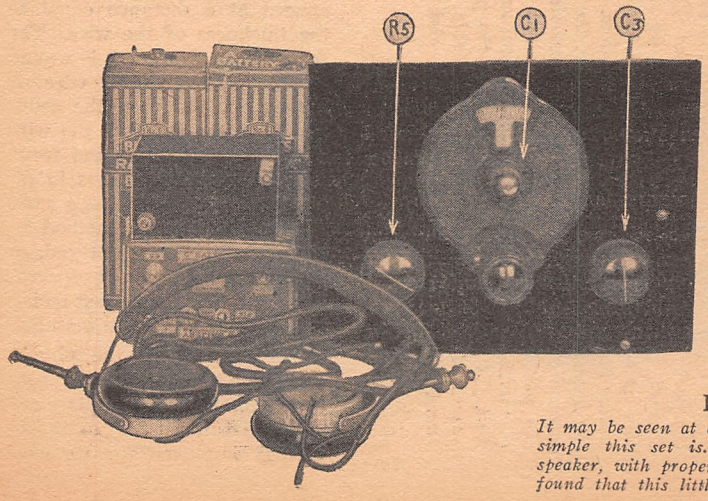


Fig. A

It may be seen at a glance how compact and simple this set is. Yet it will operate a speaker, with proper batteries; and it will be found that this little fellow "has the goods."

BUILDING THE RECEIVER

For the experimenter, a small, compact set like this may be used as a "stand-by" receiver of small cost; most of its parts will probably be found in his junk box, so that the outlay will be little or nothing. For the beginner we may say that it is not only a practical receiver, easy to build and offering few problems, but the source of much useful knowledge and experience that will be obtained by its construction and operation.

Because of its small size and portability, such a set will be very convenient for the vacationist; as it may be used readily with dry-cell tubes (199-types and, if desired, a 120 in the last stage for speaker operation) without modification from the construction illustrated here. A 4-volt storage battery or three dry-cells (4½ volts) would in that case be used as the "A" supply, with 90 volts of "B" battery on the 199s and 135 of "B" and 22½ of "C" on the 120.

THE COMPLETE CIRCUIT

The receiver illustrated comprises an untuned R.F. "blocking" stage between the antenna and the regenerative detector, which is coupled in a modification of the well-known "Hartley" circuit; together with this detector and two stages of audio amplification, the first of which makes use of resistance coupling and the latter of a transformer. It is possible, however, to use an A.F. transformer also in the first stage, if the constructor has this material handy, or is willing to invest a slight extra sum. This set was built out of the accumulation of spare parts in the writer's workshop; and, since only one transformer of very low cost was among them, this was used to keep down the outlay. The substitution is easily made, the same connections being made to the additional transformer as to the resistance-coupling unit shown. However, if a "high-mu" tube (one with an amplification factor of 30, such as the 240-type) is used in the detector socket, the amplification obtained will be practically the same as with a 201A-type and a transformer.

Many builders will prefer to use a 112A tube, or even a 171A, in the last audio stage, when operating a loud speaker. The changes required for adaptation to a power tube are simply to break the connection shown in the pictorial diagram between "B+Max" on one binding-post strip, and the upper speaker post on the other. Then the highest-voltage terminal of the "B" batteries (135 or 180 volts) is connected to this speaker post; if the 171A tube is used, however, on account of its high plate current some output protective device should be used in accordance with the instructions given by its manufacturer. Whichever of these is used, a binding post for a "C—" battery connection should be conveniently located, and the "F—" post of the transformer is connected to this instead of to the filament-return and ground, as shown. Then this post is connected to the "—" terminal of a "C" battery of proper voltage; and the "+" terminal of this battery, in turn, is led to the negative filament lead or ground post.

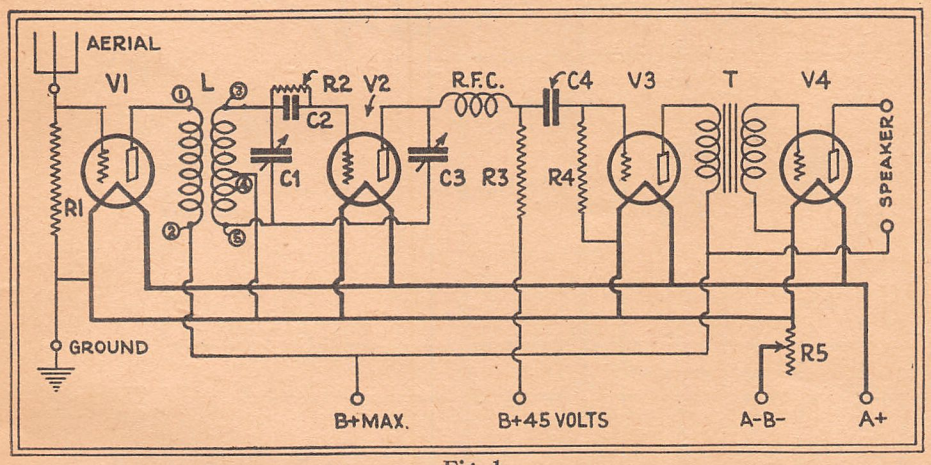


Fig. 1

The circuit of this single-control receiver will be familiar to the old heads, except for the introduction of the first tube—a needed measure under conditions of modern broadcast reception. The return from contact (4) *shown is used with a 200A detector tube; otherwise to "A+," as in Fig. 2.*

LIST OF PARTS

The parts required for the construction of the receiver as illustrated were:

One 4-inch National vernier dial;
One Pilot 17-plate Centraline tuning condenser, .00035-mf. (C1);
One Hammarlund 23-plate midget condenser, .0001-mf. (C3);
One Carter grid condenser with leak mounting clips, .00025-mf. (C2);
One Electrad fixed condenser, .006-mf. (C4) —a larger size may be used;
One Electrad grid leak, 2-megohm (R2);
Three Aerovox fixed resistors for clip mounting—two 100,000-ohm (R1, R3) and one one-megohm (R4);
Two Electrad grid-leak mounting bases, one double, one single;
One Pilot A.F. transformer, 3½-to-1 ratio (T)—two transformers may be used, one replacing the combination R3-R4-C4, as explained above;
One Carter 25-ohm rheostat (R5);
Eight X-L binding posts (nine if "C" battery is used);
Four Silver-Marshall UX sockets;
One Insuline bakelite panel 7 x 9 (or 7 x 10) inches, and two bakelite binding post strips each 2 x 3½ inches;
One coupling coil, home-made, L;
One R.F. choke, home-made—any manufactured choke may be used, if designed for use on the broadcast band;
One baseboard, 6¾ x 8¾ inches, and miscellaneous wire, small hardware, etc.;
Two Cunningham CX-301A tubes (V1, V3);
One Cunningham CX-340 tube (V2)—or CX-300A;
One Cunningham CX-301A tube (V4)—or such power tube as the builder may desire to use in the last stage.

COIL DATA

The coil L is prepared as follows: procure a length (2⅝ inches, or a trifle longer) of 1½-inch tubing; whether cardboard, fiber, hard rubber or bakelite, for the form. There are two windings, the primary and the center-tapped secondary which serves as both grid and plate coils. Drill a small hole, 3/16-inch from one end of the tube. Remove the insulation from about two inches of the end of a spool of No. 28 D.S.C. wire, and loop the wire several times through the hole and around the end of the tube; in such manner that it is held firmly and a surface provided to which a contact may be soldered. (This is contact No. 5 in the diagrams.) Wind 49 turns, and then make a twisted loop in the wire, from which the insulation may be scraped to solder on a center tap (Contact No. 4). Then continue winding 49 more turns, and at the end drill or punch another small hole. Cut off the wire, about 5 inches long from the end of the winding. The free end of the wire is brought to the bottom of the form, and secured through another small hole to make contact No. 3. The secondary is now completed; start the primary ¼-inch further up the tube, by drilling a small hole through which the wire is passed and secured at the end of the tube, as before, for contact No. 2. Twenty turns are wound in the same direction as those of the secondary; the end is cut off and secured through two small holes, as before, the last being for contact No. 1. After completing the winding, it is well to apply to the wire a light coating of airplane dope or celluloid cement, which will keep it from loosening and protect it from the atmosphere.

A small right-angle bracket, attached to the form by a small bolt and nut, will serve to mount the coil in a horizontal position on the panel; the assembly is shown in Fig. 4. A very small hole may be drilled through the panel, and a machine screw and nut will hold the coil bracket securely.

The set builder will be apt to find an unused R.F. choke among the parts in his box; but those who desire to improvise such a device will find no great difficulty in making one which will serve for this receiver. (The short-wave chokes have too low an inductance for this purpose, just as this one may have too high a capacity for short-wave work; but it will do for a broadcast receiver). The choke shown has been wound on a form or spool, which is made most readily by drilling through the center of three pieces of hard rubber or other insulation. One, which serves as the core, should be round, ⅝-inch in diameter and 5/16-inch thick. The others need not be cut to shape, but should be not less than 1¼ inches in diameter at the point nearest the center. These, with a small right-angle mounting bracket, are arranged on a 6/32 brass (not iron) screw with the core in the center, and secured firmly together with a nut, so that the assembly is rigid. Then 900 turns of No. 36 wire (with almost any kind of insulation) are wound into the slot, haphazard.

A practical hint: it will be found that this work will be greatly facilitated if the small wire is soldered to about eight inches of a larger size, to which the connections will be made, before the winding is started. This wire is brought out through a tiny hole in one of the side pieces at the bottom of the slot. After the choke is wound, another piece of the heavy wire is soldered to the end of the No. 36 for the other terminal. This length (about 12 inches) is then wound two or three times over the choke to give better anchorage and relieve the strain on the soldered joint; and finally the wire is covered with thread or tape to bind and finish it. (See Fig. 4.)

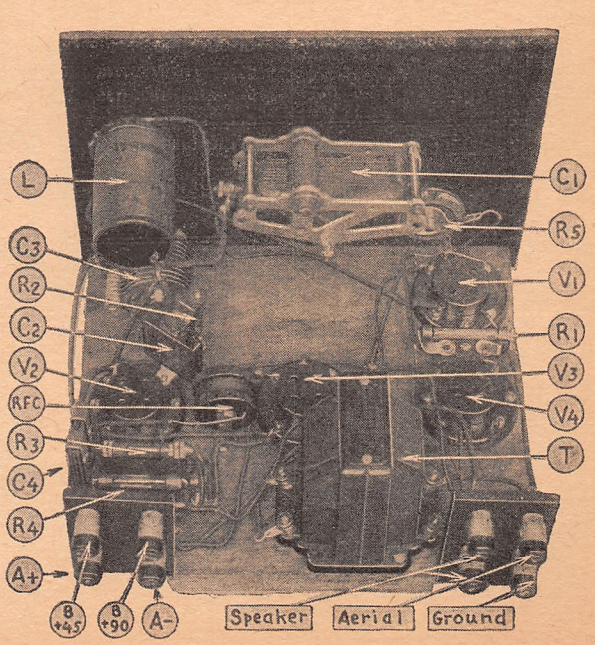


Fig. B

Small though this set is, there is ample room for placement of parts; the components will be quickly identified by a glance at the schematic diagram above (Fig. 1). The rotor plates should be grounded; if body capacity is observed, a lining of tinfoil inside of the panel (avoiding contact with leads or parts) will remedy this. The set is very selective.

ASSEMBLY OF SET

This receiver is built in two units, which are assembled separately. The sockets, choke, resistor mountings, transformer and binding-post strips are mounted to the baseboard, as shown in Fig. 2 and the photographs. The tuning and regeneration condensers, the coil and the rheostat are fixed to the panel; and then the latter is fastened to the baseboard.

The baseboard construction commences with cutting a suitable piece of wood to size (8¾ x 6¾ inches); the stock is not important, though ¾-inch will give more rigidity than a thinner piece. It is chiseled or sawed out at the corners to receive the two binding-post strips; or these may be fixed to it without going to the trouble. The writer did so in order to fit the set shown into a small cabinet which was reclaimed from the cellar for the purpose. The insert makes for added neatness.

The parts are laid out to determine their respective positions, and the sockets are fastened down with suitable wood-screws; a brass(not iron) wood-screw is used to secure the choke RFC between V2 and V3. The double-resistor mounting for R3-R4 (or a transformer if one is to be used instead) is fastened at the rear (right) of the baseboard, leaving a sufficient space, about ½-inch, between the instrument and the edge of the board, and the condenser C4 is connected across its outer ends. The second-stage audio transformer T is placed in position at the left of the baseboard, and also fastened down; half-inch wood-screws are suitable for the purpose.

The binding-post strips, which have been cut to size and drilled for their posts, are equipped with the latter and screwed into the recesses cut in the back edge of the baseboard. The single-resistor mounting, for the aerial-ground connection, is then placed between the sockets V1 and V4. The grid condenser C2, which is of the molded-bakelite, mica-dielectric type with grid-leak clips, has its mounting lug bent back so that it may be fastened directly to the "G" terminal of socket V2. It is shown in a vertical position, but this is not absolutely necessary and the constructor may follow his own judgment. The only requirement is that parts other than the grid leak R2, which is to be fixed in the clips, be kept at least an inch away.

The blocking condenser C4 is listed here as of .006-mf. capacity; this was actually employed, but the capacity is not critical. The value of the part used may be anywhere between this figure and 0.5-mf.; while condensers below .01-mf. will not pass the lowest audio frequencies, the improvement to be obtained under ordinary operating conditions did not (in the writer's mind) make it worth while to go to the trouble of obtaining a larger size. This is left, however, to the constructor's decision if he purchases a condenser.

PANEL ASSEMBLY

While the panel may be of almost any insulating material, such as wood veneer or hard rubber, bakelite was used here. It was cut to 7 x 9 inches; although 7 x 10, which has been a standard size, may be used to fit a cabinet. If the receiver is not to be encased in a cabinet, the panel length is of little importance.

The panel is drilled for the tuning condenser C1, regeneration condenser C3, rheostat R5 and coil bracket, as well as with two holes to pass the screws holding it to the baseboard. The various instruments are then mounted; the dial is fastened to the shaft of the tuning condenser and the knobs to the other two control instruments.

WIRING

In wiring this receiver, the point-to-point method should be followed as nearly as possible. Single-strand, braid-covered wire is recommended. It is always best to wire the grid and plate leads first, and then the others, which should be kept as far as possible from them. The filament and "B+" leads may be of any reasonable length, and may run side by side without introducing complications, such as will occur if a grid

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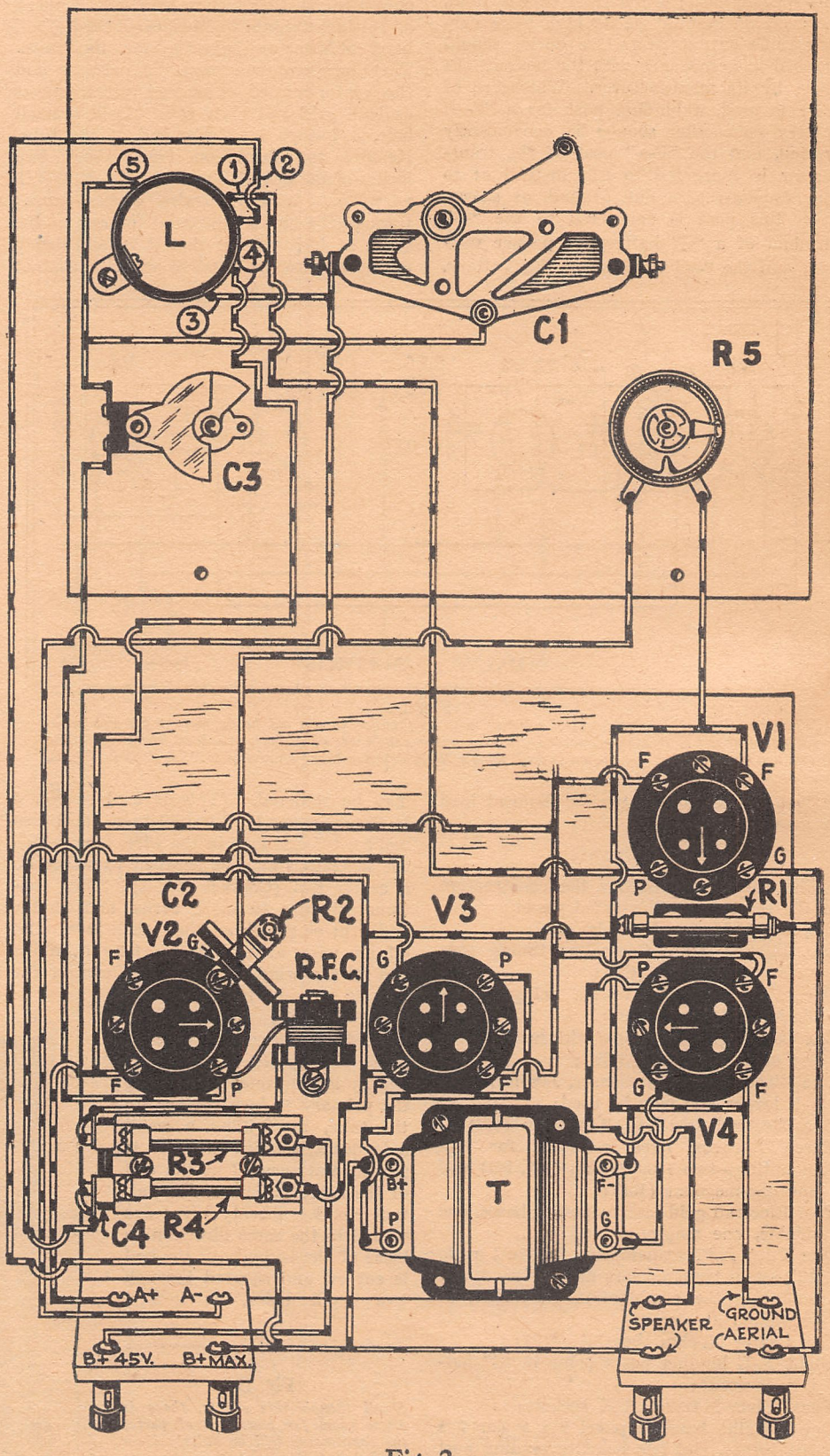


Fig. 2

The panel and baseboard are shown here separately, as they are mounted. After they are fastened together, the necessary connections may be soldered. Wires should be run straight from point to point, not at angles as they are shown here—always keeping grid and plate leads away from the others.

The Hammarlund-Roberts "Junior Hi-Q 29"

D. C. Model

A Product of Radio Engineers Who Have Designed It for the Custom and Home Builder's Convenience

By Leslie G. Biles

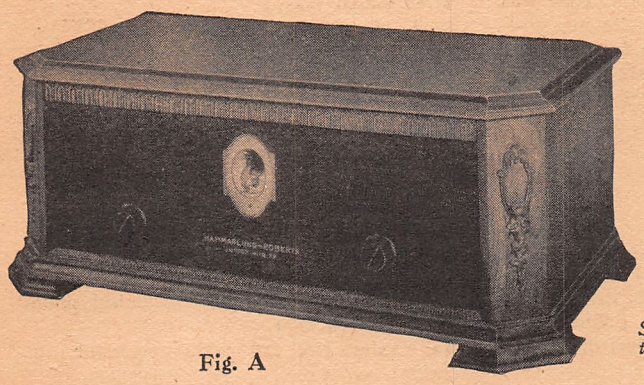


Fig. A

Shown here in a table cabinet, this panel will grace any console.

BATTERY operation is still the favorite of the fan who wants distance. In this powerful receiver we find the same screen-grid tubes as in the larger A.C. model described in our March issue; though not the elaborate filter circuits, nor the push-pull output. However, this receiver, considerably easier and less costly to build, is capable of excellent DX work in any fair location, has selectivity sufficient under the usual conditions, and gives high quality with volume suitable for the home.

"WHAT is a good receiver?" is the question which has been presented to the public jury innumerable times. At first glance, one would naturally consider the answer to this question to be of necessity weighted down with intricate details. No idea is more distant from the truth; because a few words based upon public opinion constitutes the reply. To be exact, *a good receiver is one which is scientifically designed and will perform in an admirable manner, when placed in the hands of any user, even though he is not possessed of a technical education.* The criterion of a receiver's performance is in the results secured, not by one who is sufficiently versed in radio lore to be able to secure the "Nth" degree of efficiency, but by the man who can simply assemble and wire a receiver and then manipulate the controls in conventional fashion.

Much may be said and written about the performance of a radio receiver but, since the background and basis for good performance is scientific design, we believe that an analytical discussion of the factors involved in the design of the highly-successful "Junior Hi-Q 29" receiver (direct-current model) will undoubtedly be of interest to the myriad enthusiasts who are interested in the "why" of a receiver. An analysis of the design makes it easy to understand the entire receiver, and gives one an insight into the fundamentals of its performance. It is the performance of a receiver which determines whether the investment has been wise. Hence, design details are not mere technical items but the road to "your money's worth."

SELECTIVITY AND AMPLIFICATION

True, radio engineering, during the past few years, showed a steady tendency towards the use of 7-, 8- and 9-tube radio sets; but with new wavelength allocations and the production of the D.C. 222-tube screen-grid tube at the advent of the 1929 radio season, a decided change in receiver design set in. What with the allotment of station frequencies uniformly 10 kilocycles apart, thus improving the status of the broadcasting and increasing consequent selectivity, and the gain per stage obtained with the screen-grid tube, greater economy in stages were made possible in receiver design, particularly in radio-frequency amplifying systems.

In this respect, the screen-grid tube played the paramount role. The reasons were numerous: first, it made possible greater gain per stage and effected a consequent reduction in the number of tubes required to impress a certain voltage upon the detector grid. Secondly, the reduction in tube capacity, accomplished in the design of the screen-grid tube, made possible the realization of enormously high gain in the radio-frequency amplifier without fear of uncontrollable regeneration. Hence, the devices previously necessary to curb this annoying force can now be eliminated, thus reducing the cost of the receiver.

The possibility of high gain per stage, in the radio-frequency amplifier, however, introduced associated problems. Atmospheric disturbance, the ban of the radio pioneers, has now been supplemented by man-made static which greatly decreases the ratio between signal and noise; and the high gain available with the screen-grid tube makes necessary careful consideration of the number of stages to be used in the R.F. system, because ultra-sensitivity greatly increases the effect of man-made static. The abundance of broadcast stations adjacent to the larger cities, and the increased power employed by the stations, introduce additional factors. The public demand for high-quality reception of local stations during the period of their operation augments the items which must be considered when the number of R.F. stages is determined.

Investigation of the maximum gain available from a screen-grid tube and its radio-frequency transformer, consistent with satisfactory selectivity between local stations and the ability to tune in DX stations after the locals have signed off (plus the radio-frequency "response curve" for each individual stage which produced minimum side-band-suppression) as well as detailed consideration of the items previously mentioned, showed that two stages of screen-grid radio-frequency amplification constitute an amplifying system which is conductive to high-calibre performance in every respect. The use of individual stage shielding, whereby all inductive coupling between the radio-frequency transformers, and electrostatic coupling between the condensers, is eliminated, has made possible the attainment of a high amplification level with perfect stability; so those DX stations can be received with excellent volume after the locals have signed off the air. The elimination of such interstage couplings displayed its effect upon the regeneration present in the system, by improving the shape of the resonance curve of each stage, and greatly minimized side-band suppression. The minimization of regeneration, together with the total radio-

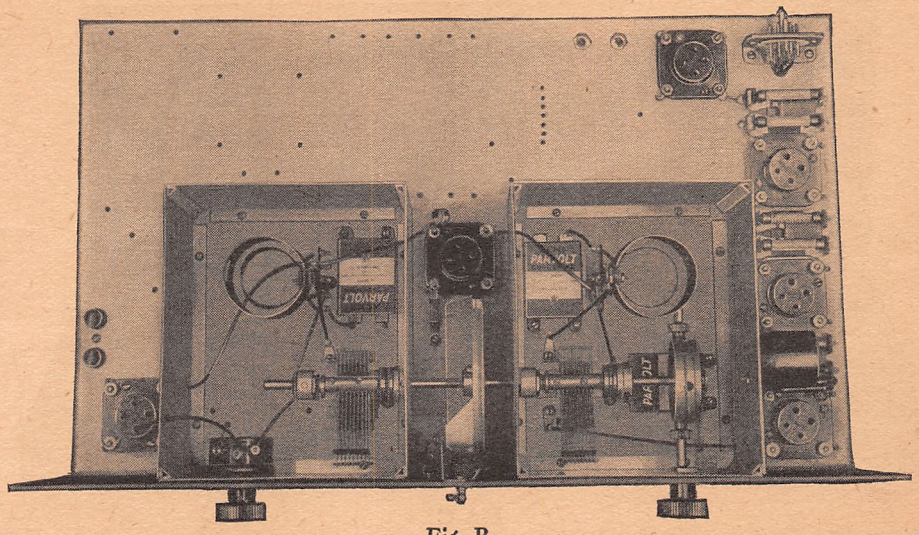


Fig. B

The simplicity of the "Junior Hi-Q 29" is apparent; and the ready-drilled chassis makes the work of assembly a trifle. There is space to add a power unit.

frequency shielding, made it possible to obtain a certain co-efficient of coupling between primary and secondary inductances of the tuned radio frequency transformers. This, again, permits a high gain per stage without a sacrifice in selectivity.

The proof of the high gain available in the radio-frequency amplifier is evident from the use of a "C"-bias detector in place of the normal grid leak-and-condenser system. The former is used in the receiver here described, despite the fact that the latter method of detection is many times more sensitive. However, the use here of the grid-bias system of detection is not solely to prove the gain obtained in the R.F. system. The true reasons are numerous: first, the fact that it permits full realization of the gain present in the radio-frequency amplifier. Secondly, it reduces distortion in the detector system because the input that may be applied to a grid-bias detector is several times that which may be applied to a grid leak-and-condenser detector system. (See Radio News for April, page 916.) Third, it improves the selective powers of the detector's input circuit.

AUDIO AMPLIFIER

The audio amplifier was likewise a subject of investigation. Of the many systems available, three stages of resistance coupling was decided upon as being the best to follow the radio-frequency and detector systems employed. The smallness of the usual gain in such an amplifier, due to the lack of step-up in the audio coupling units, is counteracted here by the use of a "high-mu" tube in the first stage. The reason for the use of this tube only in the first stage is that the permissible input voltage to any tube decreases as the amplification constant is increased. Under the circumstances, the voltage output of the detector tube is not sufficient to overload the first stage but, if this tube were used in the second-stage, its margin of "grid swing" would not permit the application of the voltage output obtained from the first stage when the receiver is tuned to a local station.

Although this factor is seldom discussed, the combination of values, of the coupling capacity and the grid leak, displays a large effect upon the audio-frequency response available from an amplifier. In this receiver, the value selected for each is such that the cumulative effect of the R.F., detector and A.F. systems provides the desired characteristics required for best performance with the average loud speaker. The use of a single 171 as the output tube was decided upon only after acoustic measurements had been made and the 700-milliwatt output available from the 171 had been found to be quite satisfactory for the average home and apartment.

LIST OF PARTS

The parts required for this receiver are as follows; those which are not lettered on the circuit are those included in the foundation unit, which obviates all drilling and saves the constructor a great deal of drudgery.

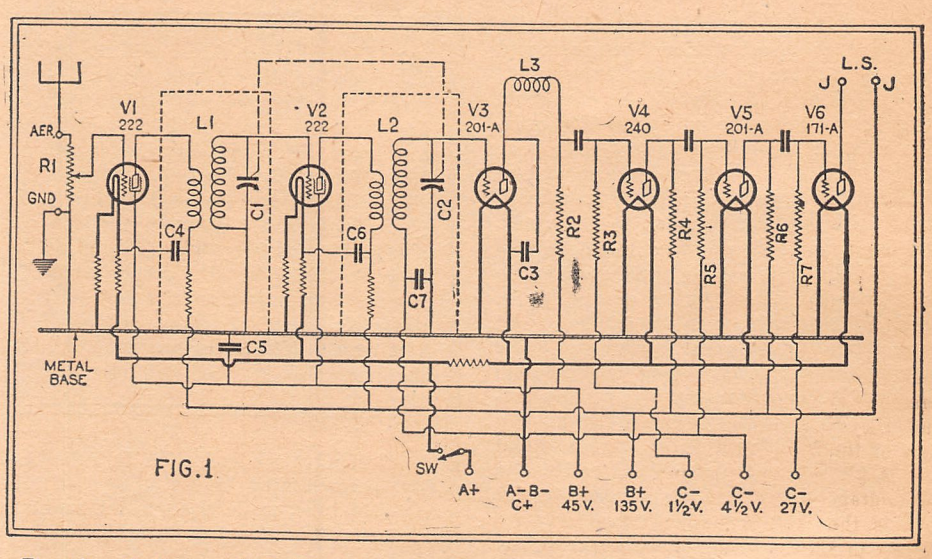


FIG. 1

The schematic diagram of the "Junior Hi-Q 29" is easily followed; its untuned antenna stage gives distortionless volume control; and its non-regenerative, plate-rectifying detector and resistance-coupling in the A.F. end show that quality as well as amplification has been a paramount consideration.

Two Hammarlund No. ML-17 .00035 mfd. "Midline" condensers (C1, C2);
Two Hammarlund No. SGT-17 shield-grid R.F. transformers (L1, L2);
One Hammarlund No. RFC-95 radio-frequency choke, L3;
One Hammarlund No. SDW knob-control drum dial, walnut finish;
Six Benjamin "Cle-Ra-Tone" sockets No. 9040, for V1 to V6;
One Sangamo .001-mf. fixed mica condenser (C3);
One Carter TP-3M tapered volume control, 3000 ohms, (R1);
One Carter No. 2 battery switch (SW);
Four Acme "Parvolt" 0.5-mf. Series 200 by-pass condensers (C4, C5, C6, C7);
Two Durham metallized resistors, ¼-megohm (R3, R5);
One Durham metallized resistor, 1/10-megohm (R7);
Two Durham "Powerohms," 1-watt, 100,000-ohm (R2, R4);
One Durham "Powerohm," 1-watt, 50,000-ohm (R6);
One pair Yaxley No. 422 insulated phone tip jacks (J, J);
One Yaxley No. 660 cable connector and cable;
Two Eby engraved binding posts ("Aer.," "Gnd.");
One Hammarlund "Junior Hi-Q29" foundation unit (containing drilled and engraved Westinghouse micarta panel, two complete aluminum shields, drilled steel chassis, shafts, coupling condensers, resistor mounts, binding-post strips, fixed resistance units, clips, wire, screws, nuts, washers, solder and all special hardware required to complete receiver).

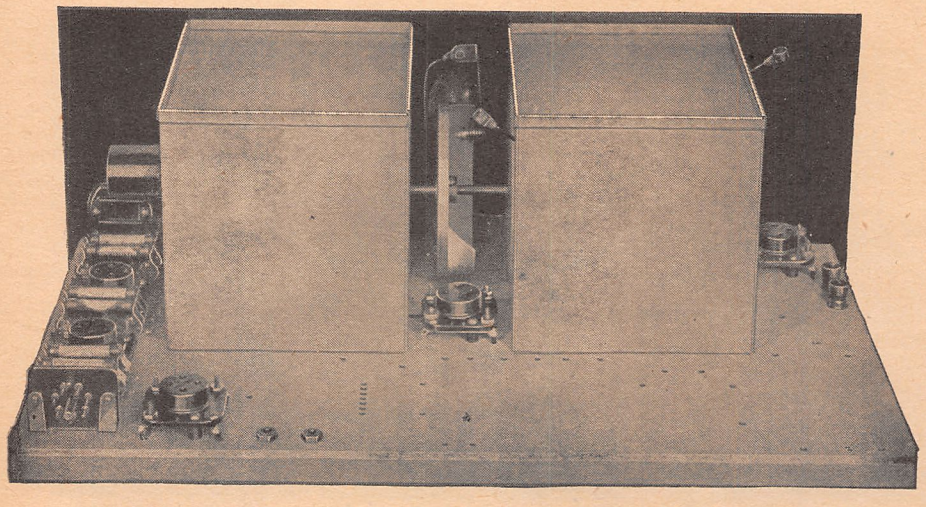


Fig. C

A rear view of the completed receiver, showing the finish of its appearance, as well as its strong mechanical construction. The compactness of the audio amplifier and the shortness of its connections is noteworthy.

GENERAL DISCUSSION

Referring again to the wiring diagram, we cannot help finding a few interesting details. Since the "Junior Hi-Q 29" in this model is designed for battery operation, low plate-current consumption is imperative; this is secured by the use of a *distinct grid-bias voltage for every tube* in the receiver. That for the screen grid tubes is secured by means of the voltage drop across a resistor in the filament circuit of each tube. The volume control is located in the most advantageous position—in the aerial circuit where it cannot diminish the selective qualities of the radio-frequency transformers and where it precludes all distortion by providing control of the signal input. Its use in this position accomplishes two other effects: first, isolation of the tuned circuits; and, secondly, single-dial tuning control of all tuned circuits independent of the aerial system. Since this control is in the form of a voltage divider, the characteristics of the antenna system remain un-

changed during the manipulation of the control.

The need for proper by-passing of the radio-frequency currents in the plate circuits of the screen-grid tube is secured by means of individual filters, interposed between the battery terminals of the plate coils and the source of plate potential. The elimination of radio-frequency currents from the audio amplifier is secured by means of a filter in the form of a radio-frequency choke and a by-pass condenser in the plate circuit of the biased detector tube. Individual filament control is supplied for the screen-grid tubes, and one major control governs the supply to the detector and the three audio stages.

Simplicity is the keynote of the entire design in both construction and wiring.

CONSTRUCTIONAL DETAILS

With respect to the constructional details of the receiver, it has been so designed that its assembly is very simple; reference to the wiring diagram will substantiate this statement. However, the constructor should note a few precautionary details—items which, though relatively simple, influence receiver performance. First, the use of the by-pass condensers (C4 and C6), in the screen-grid circuits of the two radio-frequency amplifying tubes. These condensers are indispensable and their positions in the circuit must be correct; because they influence the operation of the vacuum tube and the system. Take particular notice of the fact that they are located between the battery ends of the R.F. transformer primaries and the "A+" terminal, at the filament ends of the voltage-control resistors. The second item is the radio-frequency choke L3, employed in the plate circuit of the detector tube; this component is connected between the plate of the detector tube and the plate end of the first audio coupling resistor, with the by-pass capacity across the combination. This is of particular importance, because it influences the sensitivity of the detector tube. The third item is the detector input; the high-value capacity C7 is *in series* with the regular tuning condenser, C2, as shown. *Do not connect these two condensers in parallel;* if you do so, tuning of this stage will be impossible.

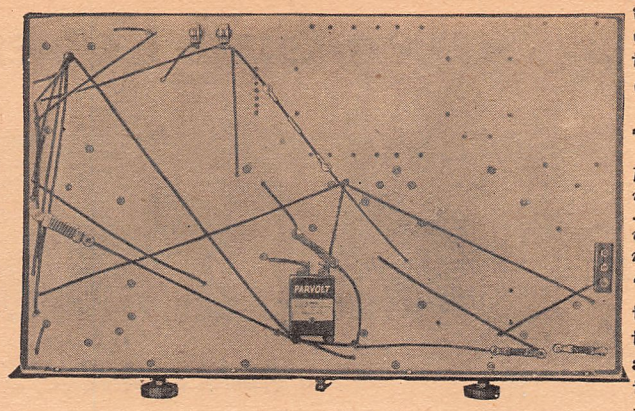


Fig. D

Wiring in the "Junior Hi-Q 29" is almost conspicuous by its absence. The "point-to-point" way is easiest and best. It must be noted that good insulation is needed.

In proceeding with the actual construction, it is best to follow the layout shown in the top view of the completed receiver (Fig. B); as this is the result of extensive experiment and has been determined to be the best for the equipment employed. It provides the simplest wiring and the shortest connections. The equipment enclosed within the individual shields should not be increased beyond the units shown. As may be seen, the two R.F. amplifying tubes are external to the shields; the input tube being at the left of the first shield, while the second stage tube is located between the two shield housings. The volume-control resistor is located within the first shield in order to preclude coupling into the wires connected to this potentiometer. The by-pass condensers associated with the two R.F. tubes are likewise located within the respective shields which house the tuning systems for these stages.

The detector tube and the three audio stages are located outside the R.F. stage shields; the detector is the one nearest to the front panel. Its position is defined (Figs. B and C) by the radio-frequency choke shown between the detector tube socket and the first audio coupling resistor. Referring to the photographs, as reproduced, the sequence of detector and audio-frequency tubes is as follows: Starting at the rear of the front panel, the first is the detector tube, the second the first audio tube. The third (second audio tube) and output tube are located near the battery cable's input plug.

The arrangement shown affords the shortest connections between the audio coupling units and the respective sockets. Wiring of the system is carried out (Fig. D) beneath the sub-panel, with the exception of the two radio-frequency stages. As evident from Fig. B, all wiring of these units is located within their respective shields.

The by-pass condenser connected between the chassis ("A— B—") and the "B+" terminal is located on the underside of the sub-panel, as shown in Fig. D. The input terminals of the receiver are the two binding posts shown in Figs. B and C; the output connections are the two tip jacks visible in the neighborhood of the power tube.

In view of the fact that the chassis is of metal and is a part of both the "A" and "B" systems (since the "A" and "B" minus terminals are connected thereto), it is important that all the wires passing through the holes in the sub-panel have perfect insulation. Care should be exercised, when threading the wires through the holes in the sub-panel, to preclude the possibility of scraping the insulation; for this reason, all sharp right-angle bends in the wiring passing through these holes should be avoided.

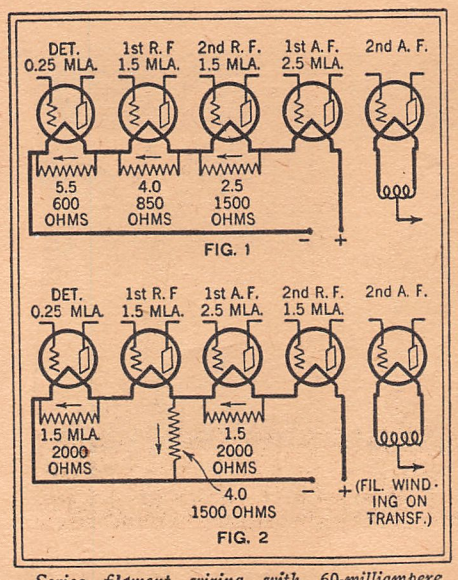
(*Continued on page* 1045)

By-pass Resistors for Series-Filament Operation

By J. H. Arnold

THE use of tubes requiring low filament current (such as the 199 type) with the filaments connected in series and powered by a "B" unit of the usual type, capable of delivering 75 milliamperes or more, has become quite popular as a method of electrification. With such an arrangement, no A.C. is introduced into the circuit at any point—as in the 226-type A.C. tube—and consequently a low cut-off frequency may be used in the audio amplifier without introduction of A.C. hum.

It is necessary to use by-pass resistors across the filaments to keep the current through all tubes at a value of 60 milliamperes; as otherwise the filament current through the last tube in the string will exceed that through the first tube by the sum of the plate currents. The usual resistance values are 600, 850, and 1,500 ohms, shown in Fig. 1. The 600- and 850-ohm resistors are odd sizes, and consequently difficult to obtain from most radio stores. By making use of the revised connections shown connected across each tube filament as in Fig. 2, standard resistors of 2,000, 2,000, and 1,500 ohms may be used. By connecting the 1,500-ohm resistor across two tubes, the 4-milliampere plate current of the other two tubes is by-passed by one resistor instead of two. A higher resistance value may thus be used across the detector tube; namely 2,000 ohms instead of 600.



Series filament wiring with 60-milliampere tubes requires some compensating resistors. Fig. 1 is a usual, and Fig. 2 an improved circuit.

By the application of this idea, sets using more than four 199-type tubes in series may be designed to use resistors of not unusual values, remembering that the resistance in ohms equals three times the number of tubes across resistor, divided by the current in amperes.

By suitable changes in the order of the tubes, as some will draw higher plate currents than others, an arrangement can readily be found which will make use of 500-, 1,000-, 1,500-, and 2,000-ohm resistors rather than of odd sizes.

It is probable that many constructors have feared series wiring overloads filaments, should a tube be taken out of its socket. As the diagram shows, however, the contrary is true; the whole circuit is broken and becomes dead.

The "A. C. Screen-Grid DX-er"

An Old But Efficient Distance-Getting Circuit Brought Up-to-Date with Newly-Developed Tubes

By Robert Hertzberg

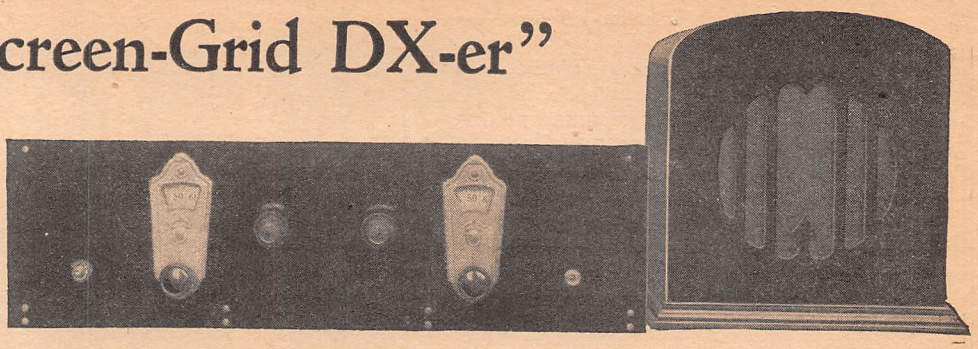


Fig. A

The panel appearance is attractive and, as may be seen, will suit almost any cabinet.

IN spite of the many advantages over the normal three-element tube which it possesses, the UX-222 has achieved comparatively little popular application, because of its requirement of a direct-current supply for its filament. Custom set builders, who have been intrigued by its possibilities as a super-sensitive radio-frequency amplifier, have been forced to overlook it almost entirely when building receivers; as the first question of all prospective customers is, "Does this set work off the house current?"

Of course, there are "A" power units which replace the storage battery and work very well over long periods of time; but the luxurious convenience of A.C. operation is a selling point that is acknowledged by all.

The recent marketing of the A.C. screen-grid tube by large tube manufacturers relieves this situation, and opens up a virtually new field for the constructor. The circuits incorporating it are simplified without reduction of sensitivity; the storage battery and the "A" unit may alike be forgotten; the whole power pack is built right into the receiver, while the number of tubes is reduced. The hum introduced is at a minimum; for the new tube has the same filament characteristics as the well-known 227 type, with the advantage of operating from the same filament transformer or winding.

RADIO NEWS, therefore, here introduces to its readers one of the first receivers designed particularly to take advantage of the new tube. It has been called the "A.C. Screen-Grid DX-er" because this name covers its three salient features: the convenience of A.C. operation, the sensitivity by screen-grid high amplification, and the tremendous DX range of the set. The screen-grid R.F. stage is tuned, assuring good selectivity; while the detector is regenerative, assuring maximum sensitivity. For all normal local and middle-distance reception, the detector regeneration control knob is left at minimum; for the screen-grid tube alone is sufficiently sensitive. After the family goes to sleep you can crowd up to the loud speaker, nurse that knob a little, and start logging stations between both coasts.

REGENERATION preceded by a tuned R.F. stage has long been known to offer more distance, tube for tube, than any other circuit. Now the availability of an A.C. screen-grid tube with enormous amplification offers to the constructor an opportunity he has long been waiting for. This is the first set using this new amplifier available to the set-building fraternity, and will be of undoubted interest to all. It is a little giant, as the picture above indicates.

The regeneration control is not the regular volume control of the set, as in most circuits with a single R.F. stage and regenerative detector. Instead, a potentiometer which varies the voltage on the screen-grid of the R.F. tube is employed. This arrangement is highly effective, and prevents distortion by ensuring the detector against overloading. Thus, the quality of the signals from local stations is not destroyed; as it is in many highly sensitive sets designed for the utmost DX.

The set illustrated in the accompanying photographs is a complete receiver; requiring in addition to the speaker only aerial and ground connections and a source of 110-volt alternating-current. It uses five receiving tubes and one rectifier, the latter of the 280 type. While a complete assortment of parts, including drilled and engraved front and sub-panels, can be obtained in kit form (and, when so purchased, saves a great deal of labor) individual parts are widely available; so, if you already have sockets and binding posts and transformers, for instance, you will not have to spend additional money on duplicate parts.

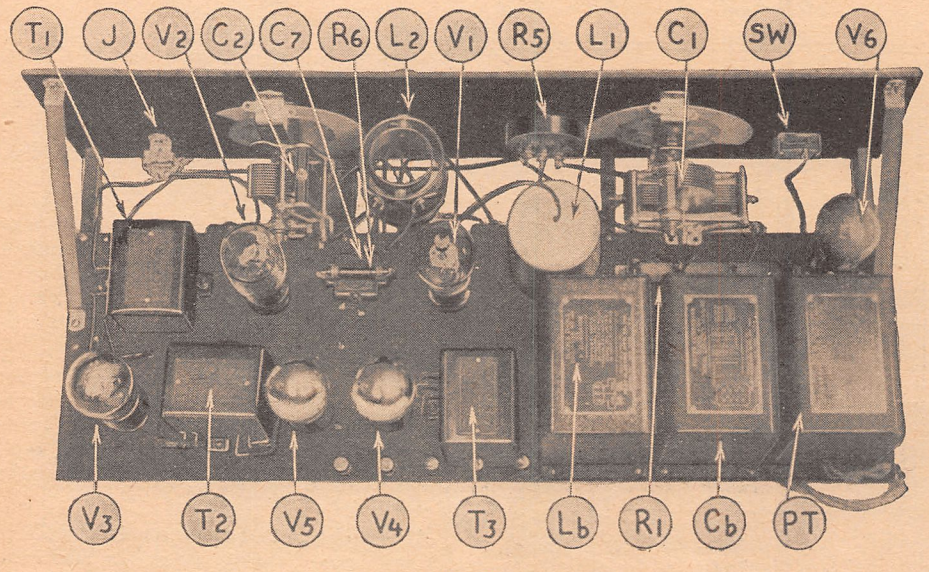


Fig. B

The separated panel and sub-panel assembly, well illustrated in this top view, is very strong, and convenient for the constructor. There is practically no wiring above. The compact power-unit assembly appears at the lower right. Note the shielded, plug-in inductor L1, with its direct connection to the screen-grid amplifier V1.

PARTS REQUIRED

The complete list of parts used in the receiver, as illustrated here, is as follows:

One Pilot power transformer No. 398 (PT);
One Pilot filter condenser block No. 396 (Cb);
One Pilot double choke-coil block No. 395 (Lb);
One Electrad voltage divider (R1);
One Pilot 1200-ohm fixed resistor (R2), one Pilot 2250-ohm resistor, (R3), and one Pilot 1200-ohm resistor (R4);
One Centralab 200,000-ohm potentiometer (R5);
One Twin Coupler antenna coupler (L1);
One Twin Coupler interstage R.F. transformer, with tickler (L2);
One Pilot variable condenser No. 1517, .00035-mf. (C1);
One Pilot variable condenser No. 1523, .0005-mf. (C2);
One Silver-Marshall A.F. transformer No. 255 (T1);
One Silver-Marshall push-pull input transformer No. 257 (T2);
One Silver-Marshall push-pull output impedance No. 258 (T3);
Four Pilot fixed condensers No. 59, each .01-mf. (C3, 4, 5 and 6);
One Pilot grid condenser No. 51M, .00025-mf. (C7);
One Pilot fixed condenser No. 53, .001-mf. (C8);
One Tobe Deutschmann by-pass condenser, one-mf. (C9);
One Pilot single, closed-circuit telephone jack (J);
Three Pilot UX-type tube sockets No. 214 (for V4, V5, V6);

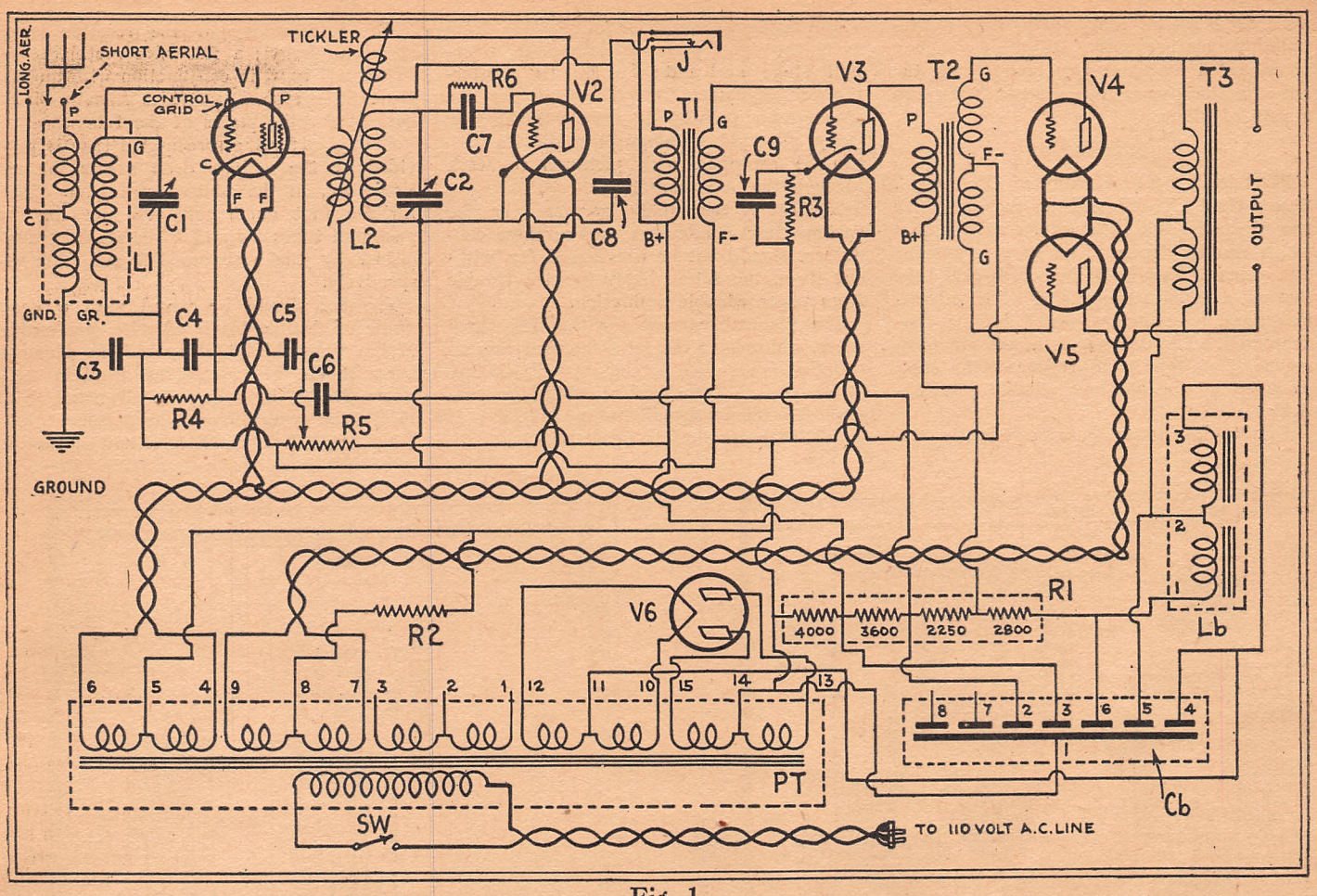


Fig. 1

While the circuit above shown may appear complicated, close examination will show that the units enclosed within dotted lines, representing sealed apparatus, account for a large part of this. The actual connections are quickly made; especially with a panel and a sub-panel drilled ready for use. The use of the same voltage on the first three tubes simplifies the filament circuit; and the push-pull power stage gives tremendous reserve of volume for low-note amplification. The choke provides a filter for the large plate current, protecting the speaker, which has no D.C. voltage across its windings.

Four Pilot UY-type tube sockets No. 215 (for L1, V1, V2, V3);
One front panel, 7x24x¼-inch, and sub-panel, 7x23x¼-inch;
Four Pilot sub-panel brackets No. 3, 8x1-inch;
One Aerovox grid leak, 2-megohm (R6);
Two Pilot vernier dials, No. 1282L (for condensers C1 and C2);
One Carter power switch (SW);
Five X-L binding posts;
One Ceco AC-22 screen-grid tube (V1);
Two Ceco N-27 A.C. (227) tubes (V2, V3);
Two Ceco J-71A (171A) tubes (V4, V5);
One Ceco R-80 (280) tube (V6).

ARRANGEMENT OF PARTS

The placement of the parts on the front and sub-panels is made very clear in the various accompanying illustrations. The front panel, shown in the heading of this article, holds the two vernier dials, to which the variable condensers C1 and C2 are attached; the power switch, at the left; the telephone jack, at the right, and the knobs for the potentiometer R5 and the tickler of the interstage transformer L2 between the dials. The jack, by the way, is not for loud-speaker connection, but for a phonograph pick-up; thus making a very convenient means of connection.

The coil L2 is nothing but our old friend the three-circuit tuner; as it consists merely of a primary and secondary on a bakelite tube, with a tickler rotating in the end of the secondary.

The power transformer PT, the filter-condenser block Cb, and the choke-coil block Lb used in the original model of the "A.C. Screen-Grid DX-er" are all of the same size, and differ only in the appearance of their terminal blocks. They occupy the left section of the sub-panel; with the socket for the rectifier tube in front of the transformer and with the voltage divider in front of the other two units.

The antenna coupler L1 is enclosed in a shielding can, which fits into a regular five-prong socket. The socket for the screen-grid tube V1 is located a little to the right of the latter, and is followed across the sub-panel to the right by the grid condenser and leak C7-R6, the detector socket (V2), and the first-stage audio transformer T1. The first audio tube V3 and the components of the push-pull stage occupy the space along the rear edge of the sub-panel.

The sub-panel is supported by four molded bakelite brackets, which are fastened to the front panel. The mechanical

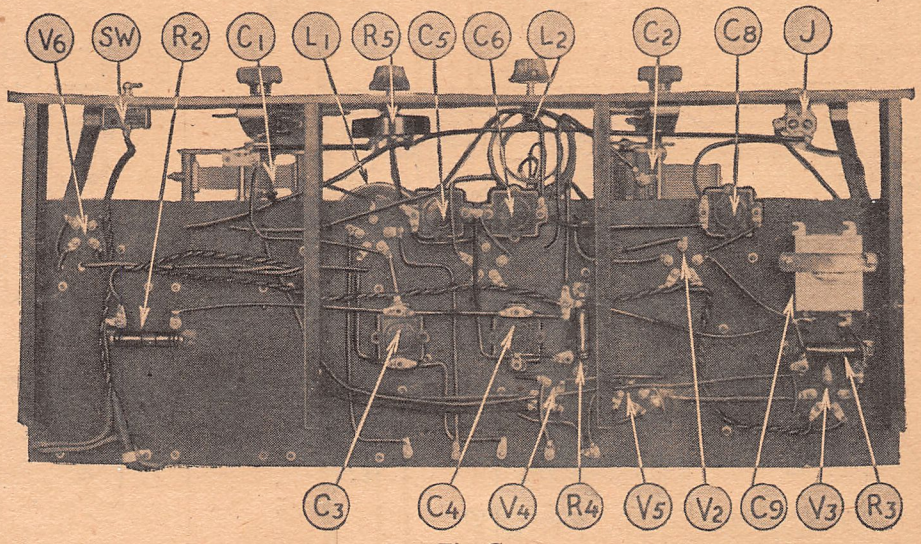


Fig. C

Viewing the under side of the sub-panel, it will be seen how many of the connections are made here directly in the "A.C. Screen-Grid DX-er." The elaborate by-passing provided is essential to quality. The jack J is conveniently placed for connecting a phonograph pick-up.

assembly is rather easy, particularly if prepared panels are used. All the parts may be mounted in about two hours, with the aid of nothing more than a screwdriver and a pair of pliers.

CIRCUIT DESIGN

Electrically, the circuit of the "A.C. Screen-Grid DX-er" will be recognized as one of sound and conservative design, and which can be depended on to give results. The antenna feeds into the screen-grid tube through a coupler comprising a tapped primary and a secondary tuned by the condenser C1. The detector is of the standard regenerative type; the regeneration being provided by the old and reliable rotating-tickler method.

The detector output goes through the jack J to the first-stage transformer T1; from which the signal proceeds through the push-pull stage and out through the center-tapped impedance T3. The jack for the phonograph pick-up is very valuable; as many old-style phonographs, still in use, can be equipped with pick-ups to work through the A.F. amplifier.

The set is thoroughly by-passed by the various fixed condensers shown; these condensers should not be overlooked for, without them, the set is likely to give trouble from uncontrollable oscillation.

The filament current for the first three tubes, which have the same filament characteristics, is supplied by the 2½-volt winding of the power transformer; while the current for the push-pull tubes (171A's) is furnished by one of its 5-volt windings.

The "B" section of the receiver is of standard design; a full-wave rectifier tube of the 280 type, in conjunction with an efficient filter system, provides smooth direct current for the plates of the tubes.

Grid bias for the screen-grid tube is provided by the voltage drop across the resistor R4, in the plate-return lead. Bias for the first audio tube V3 and for the push-pull tubes V4 and V5 is similarly furnished by the resistors R3 and R2, respectively.

The set should be wired with a good grade of flexible insulated wire, preferably of the "'push-back" kind, and the filament wires should be twisted, as usual in A.C. sets. Study the schematic diagram (Fig. 1) for the general circuit arrangement, and the pictorial layouts (Figs. 2 and 3) for the

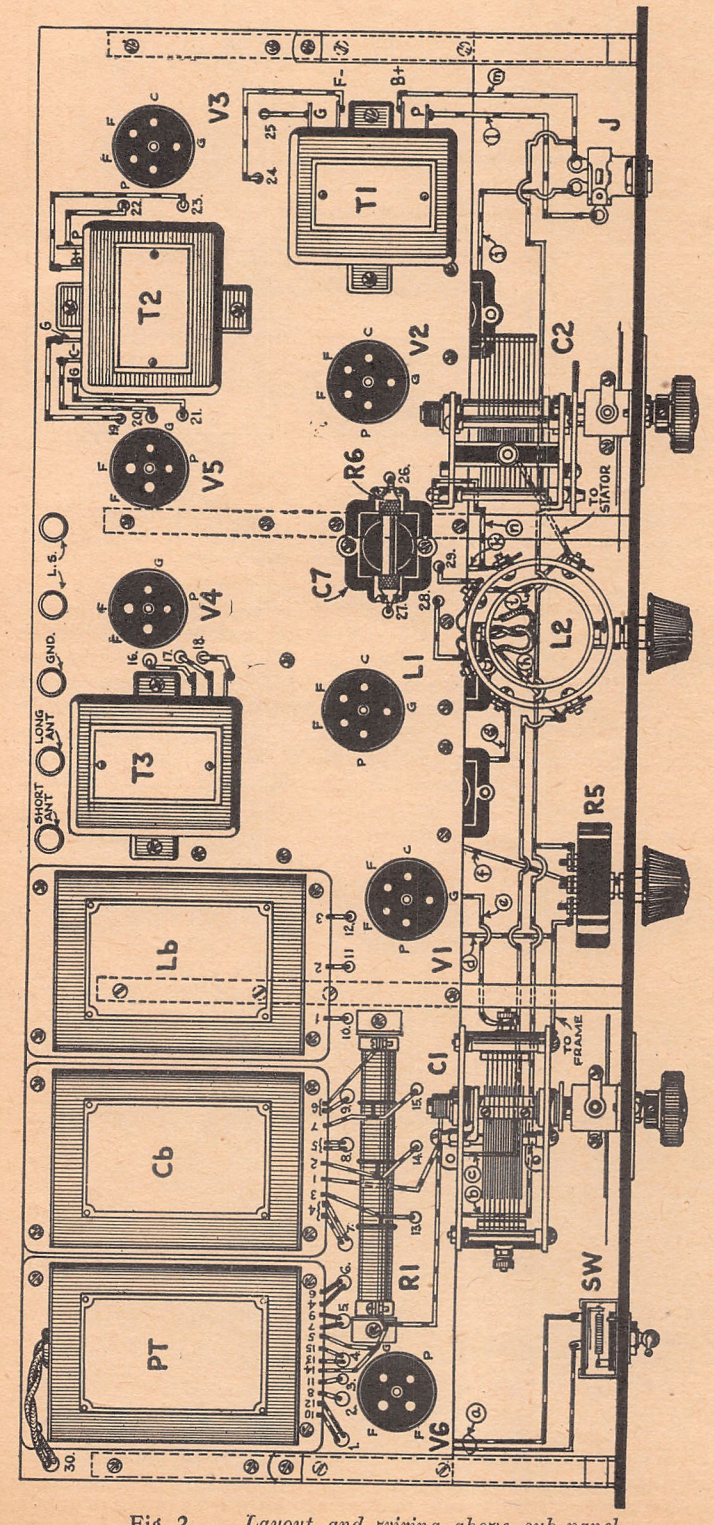


Fig. 2 *Layout and wiring above sub-panel.*

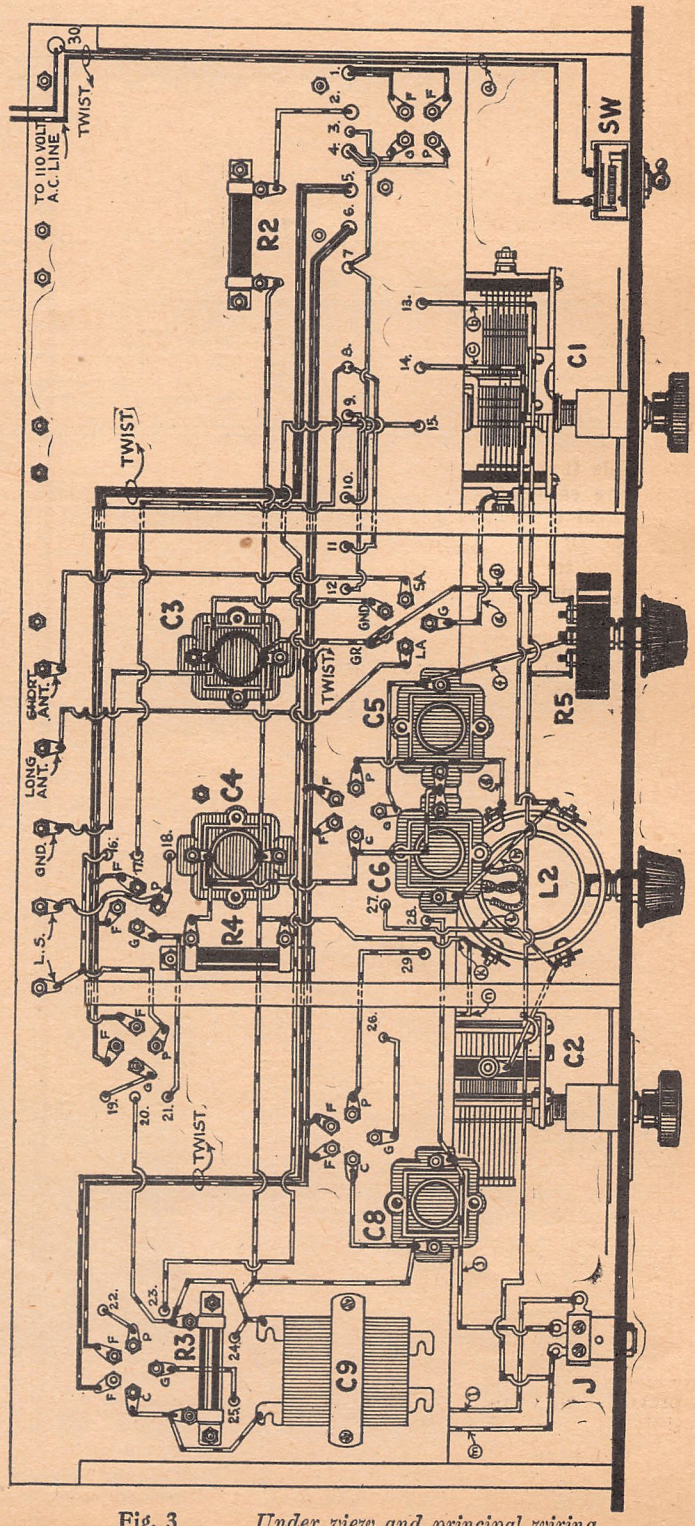


Fig. 3 *Under view and principal wiring.*

actual disposition of the wires. These are illustrated here with numerous right angles, so that the connections may be followed clearly; but, as one photograph shows, the leads may be in some cases run more directly.

OPERATING HINTS

The "A.C. Screen-Grid DX-er" should be handled like the old Browning-Drake and similar sets. For local reception ("local" with this outfit means almost everything within 800 or 1,000 miles), the tickler of L2 is set at its minimum—at right angles to the secondary—and the volume is controlled by means of the potentiometer. The two dials tune more or less alike, and stations are easily located on them.

For real distance work, keep the potentiometer all the way up, and advance the tickler so that the set produces the soft-hushing noise characteristic of regeneration. You can then "spot" weak stations by the squeals they produce; and you can bring them out by first adjusting the tuning condensers carefully, and then turning down the tickler a hair's breadth at a time. You will learn all the tricks in a few evenings, or you can teach them to a customer after one or two visits.

HINTS ON OPERATION

No radio fan will ever be able to boast about transcontinental DX broadcast reception unless he has gone to the trouble of erecting a really good aerial and installing a really good ground. The "A.C. Screen-Grid DX-er" is a highly sensitive receiver; but it will not overcome the initial handicap imposed on it by a leaky aerial or a high-resistance ground.

The best possible aerial for broadcast reception is a single length of bare or enamelled copper wire, rising straight up into the air to a height of about 200 feet. Since 200-foot masts cannot be purchased for $18 in the local radio shop, most set owners will have to struggle along with something less imposing in the way of a pick-up system.

The general rule to follow is to raise the wire as high as possible and to keep it thoroughly insulated from nearby objects by means of pyrex or other good insulators that will not soak up moisture.

The over-all length of the wire, from the point where it enters the house to where it ends finally at the furthest insulator, may be anywhere between 100 and 300 feet. Most people regard the horizontal wire and the vertical lead-in as separate components; actually there is no point at which the lead-in ends and the aerial begins. The whole exposed wire, regardless of the angles which portions of it may take in relation to the surface of the earth, is the aerial. For that matter, the wire running from the aerial binding post on the set to its junction with the lead-in at the window also acts as an aerial. If you don't believe it, try disconnecting the wire at the window, and see how many stations you can tune in.

The necessity for clean, well-soldered joints has often been emphasized. Twisted joints do very well for a few weeks; but, after they have been fanned by the gentle breezes from chimneys and ventilator pipes for a while, you will notice signals do not come in quite as well as they used to. The best way to erect an aerial is to start at the far end and to run the wire in one unbroken stretch down to the window, where you can solder with a fresh, hot iron. It's all very well to talk about soldering joints in the aerial, but, if you've ever dashed up three flights of stairs with a red-hot iron, only to find it lukewarm when you reached the roof, you'll know the advice is not easily applied.

A good ground is more easily obtained. The cold-water pipe is the old stand-by, and

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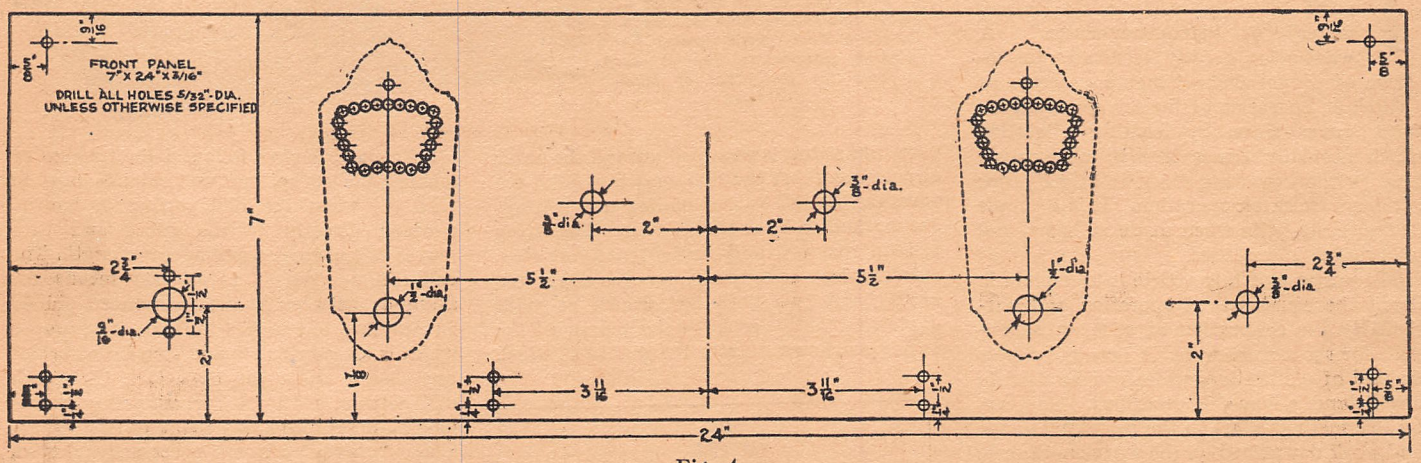


Fig. 4

The drilling diagram of the "A.C. Screen-Grid DX-er" for those who wish to do the work. Templates furnished with dials should be used.

More About Harmonics of Long-Wave Broadcast Stations

NOTWITHSTANDING the explanation in our March issue (page 841) of the appearance of broadcast stations in short-wave receivers, many of our readers continue to inquire about the phenomenon; especially as they note long-distance reception on stations of comparatively low power in this way at times.

Some fans may have noted the absence or weakness of the harmonics from some of our largest broadcast stations; this is due to the method of operation of these large transmitters, which incorporate what is known as the "master-oscillator" system. A transmitter of this type uses a small tube as the producer of the radio-frequency carrier-wave oscillations, and all the other tubes in the transmitter proper are radio-frequency amplifiers. These radio-frequency amplifiers are very carefully neutralized to prevent them from producing oscillations of their own and each of them is tuned to the wavelength that the transmitter is operating on. Because of the tuning in these amplifiers the harmonics are not amplified or, at least, they are comparatively weak in comparison to the fundamental when they leave the amplifier. Most of the smaller transmitters, on the other hand, have their oscillator tubes directly coupled to the aerial and the harmonics are transmitted quite strongly. In some of these stations, tuned filters are used to suppress some of the strongest harmonics; but it would be impractical to suppress more than the first few because of the amount of apparatus and expense required for the filters.

Although the harmonics produced by transmitting stations are apparently only a nuisance to the short-wave listener, they have uses in the field of communication. In a master-oscillator transmitter, the oscillator may be tuned to one frequency, while the amplifiers are tuned to its harmonics. In this way the transmitter may be operated on a wavelength lower than the fundamental of the crystal-controlled oscillator and, by coupling different amplifiers to the oscillator, a number of signals may be sent out simultaneously. This latter system is sometimes employed in commercial radio work.

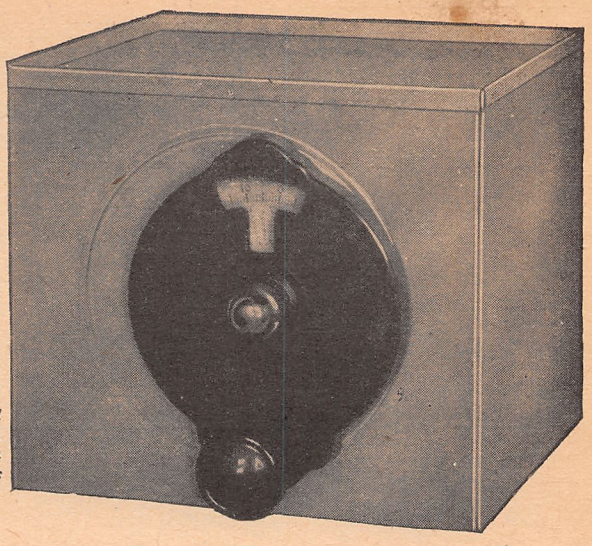
While discussing the subject of harmonics, it is interesting to follow the sequence of the various harmonics of a broadcasting station. Suppose we have a certain station operating on a wavelength of 399.8 meters; this is equivalent to 750 kilocycles. The second harmonic will have just twice the frequency, or 1,500 kilocycles. The third harmonic, which is the lowest that can be heard at any great distance from the transmitter, is at 2,250 kilocycles. The following harmonic are then at 3,000, 3,750, 4,500, 5,250, 6,000, etc., kilocycles. The corresponding wavelengths are 133.3 meters for third; 100 for the fourth; and 80, 66.6, 57.1, and 50 meters for the consecutive following harmonics. Given the order of a harmonic, it is necessary only to multiply the frequency or divide the wavelength of the fundamental by that number.

Considering the number of broadcast stations operating between 200 and 550 meters, it is not surprising that so many stations may be heard with a sensitive short-wave receiver. However, the above explanation may help to clear up this matter in the minds of some of our readers.

Wavemeter Hints for the Short-Wave Listener

How to Construct and Calibrate This Handy Guide to Operation at the Higher Frequencies

By A. Binneweg, Jr.



A shield can, of the type most used in present-day receiver construction, makes a handy metal cabinet for a plug-in wavemeter; for it keeps down the annoyance of hand-capacity.

THE fundamental measuring instrument in radio work is the "wavemeter" or "frequency-meter." A wavemeter greatly facilitates the location of proper dial-settings and serves as a check on operation of the set, especially on short waves since, by locating a station which normally comes in well at a given time (without waiting for it to "sign"), one obtains a check on operation. It is a simple device, costs little when made at home, and is of major importance.

The purpose of this article is to explain in detail the construction, operation and particularly the calibration of such an instrument for short-wave work. A new and simple method of calibration, which can be used in any listener's home, is described. One can, by this method, start in the broadcast range and work downward on the wavelength scale as far as may be desired. The wonderful DX results obtained, and the exceptional musical programs, which can be readily picked up from the many foreign stations using the short waves, are too well known to Radio News readers to be elaborated upon here. A good short-wave wavemeter will greatly increase the pleasure to be obtained from a short-wave receiver, and simplify the location of foreign stations.

CALIBRATION-CURVES

For the best results, all ordinary wavemeters must be provided with "calibration-curves." Each graduation on the wavemeter-dial corresponds to a definite wavelength or frequency, and the calibration curve is used to convert dial settings to corresponding wavelengths. The following is an easy way of looking at the calibration curve. In Fig. 1, at A, is shown the graduated half of an ordinary dial. Each graduation, of course, corresponds to a definite wavelength (with a given coil) which may be marked opposite the corresponding graduation on the dial; the principle, of course, applies to any waveband. Imagine that a very thin string is wrapped around the outer circumference of the dial, and that both the wavelengths and corresponding dial settings are marked on it, as shown at A. The string is then removed and straightened out on a smooth piece of white paper (as suggested at B) and two lines are drawn at right angles, in the lower left-hand corner of the paper, as shown. From the points at which

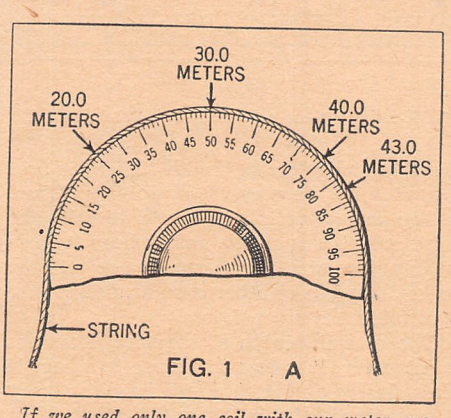


FIG. 1 A

If we used only one coil with our meter, we might mark the readings on the dial; but it is more accurate to make a chart.

the marks appear on the string lines are drawn at right angles to the two perpendicular marginal lines just drawn (OX, OY). It will then be found that it is more convenient to mark the wavelengths and dial settings on the marginal lines instead of directly on the curve. The calibration curve then will look like that shown in Fig. 2.

This description may sound simple to the advanced radio listener or technical man, but it will aid greatly the majority of listeners to understand the useful calibration-curve, so often met in this type of work. Paper with printed squares upon it, or "graph" paper, will be found very convenient for the purpose. Such paper may be found at any stationer's, and will always be valuable to the radio experimenter in many ways.

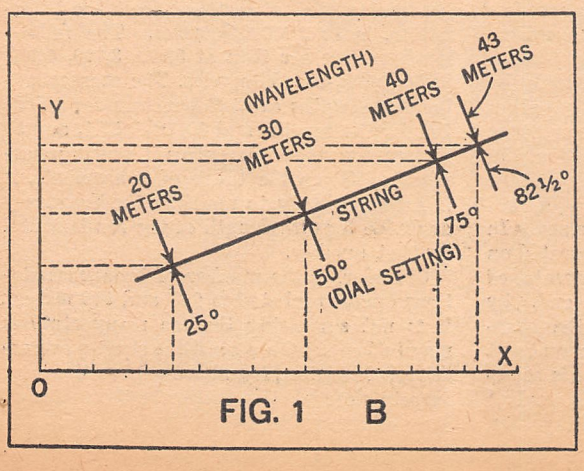


FIG. 1 B

A glance at this shows what is meant by "straight-line" this or that, with reference to a condenser. Straight-line wavelength is shown here; plotting by frequency will give a curve.

Of course, having followed the process of making the curve, one understands how to read it; when the dial setting is known, proceed directly to the curve and then across to the corresponding wavelength. The calibration-curve offers an easy means for filling in between known, calibrated points. In practice, one makes the curves on paper which is already ruled, and convenient scales are chosen along the *axes* OX, OY; each dial setting, with its corresponding wavelength, determines one point on the curve. These "curves" are not necessarily curved, and with the proper condensers, they often become straight lines; which, from a mathematical standpoint, may be called curves.

The simplest method for calibrating a short-wave wavemeter is, first, to look up the wavelengths of the known stations, and then to plot these opposite the corresponding dial settings of the wavemeter; thus obtaining the calibration-curve for the instrument. Each station is first tuned in accurately on a short-wave receiver, and the dial setting for its wavelength is then found and marked on the wavemeter. This is accomplished by bringing up the wavemeter-coil to the secondary of the receiver and listening for the familiar click in the receiver telephones, as described below.

CALIBRATION PROCEDURE

Stations may be accurately tuned in by means of a receiver and, if the wavelength of the station is known, this can be transferred to the wavemeter where it will always be available. To transfer a receiver-setting to a wavemeter, *the receiver must be in a regenerative condition.* The wavemeter, of course, must include in its range the frequency to which the receiver is tuned. If you are in doubt, use a condenser and a coil about the same size as those used in the receiver. Bring the wavemeter about one foot

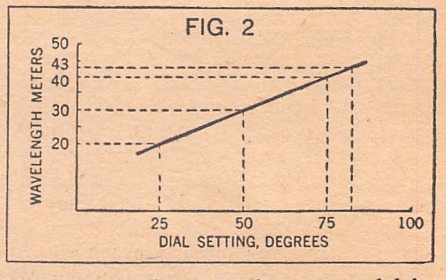


FIG. 2

It will be handiest to purchase paper ruled in squares, and make our charts on a large scale—one for each coil used. We shall probably find our lines not straight.

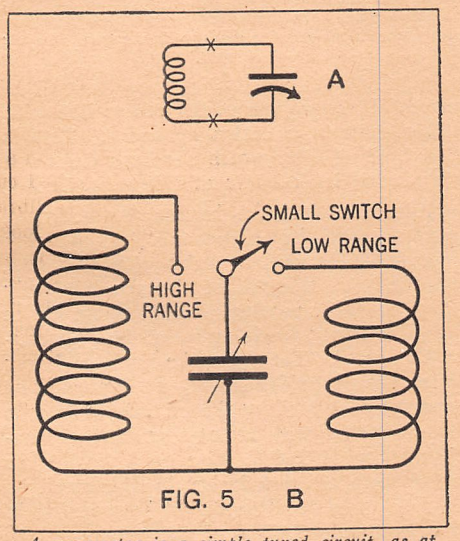
from the secondary coil of the receiver's detector circuit, and vary the wavemeter's condenser until a click is heard in the phones of the receiver. If the coupling is too close, two clicks will be heard; move the wavemeter away until a loud click is no longer heard, that is, until the receiver gently "slides" into and out of oscillation, at one particular dial setting. If the receiver is properly adjusted, this result is quite simple to obtain. At this position, note the exact setting of the wavemeter and look up its corresponding wavelength. When four or five points have been determined for the wavemeter, plot a curve in the manner to be described. Points incorrectly determined will not lie on the smooth curve drawn through the others; these may be disregarded.

However, in some localities, it is often difficult to locate sufficient short-wave stations, the wavelengths of which are known accurately; so the writer has developed a simple method which requires the operator to know the wavelength of only one short-wave station. It makes little difference what that wavelength may be.

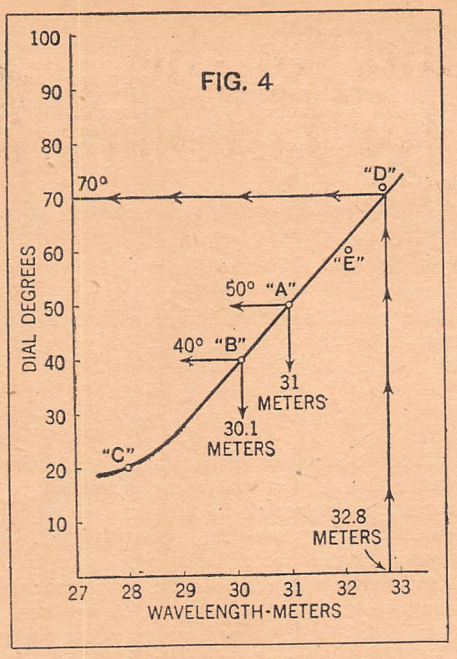
METHOD OF CALIBRATION

The broadcast stations which operate in nearly every community offer an accurate means for short-wave wavemeter calibration. The *harmonics* from these stations (See the March RADIO NEWS, page 841) although usually not directly audible, may be used for calibration purposes if a one-tube regenerative receiver is used. Harmonics as low as 10 meters may be heard, even though the station itself may be at quite a distance. These harmonics are present in the oscillating circuit of the regenerative set and may be transferred to the short-wave receiver. A simple regenerative receiver (*which should not be used for broadcast reception,* but is good for this work, and economical) is shown in Fig. 4; any regenerative receiver, constructed of junk-box parts, may be used for this purpose, however.

The long antenna, which is ordinarily used for either short-wave or broadcast reception, is connected to the broadcast receiver and the latter is arranged as for ordinary broadcast reception. The short-wave receiver, employing one stage of audio amplification, as usual, is placed near the broadcast receiver but is *not* provided with antenna or ground connections. With the broadcast receiver in an oscillating condition, tune in a fairly powerful broadcast station. Tune the oscillating receiver into exact synchronism with the broadcast transmitter, that is, tune it directly *on the wave;* in this condition the "squeals" heard on each side of the correct wave will disappear and only the music is heard. For better results, select a fairly powerful station; all stations are by law required to maintain an accurate frequency, but the larger stations are most closely regulated, as a rule, at present.



A wavemeter is a simple tuned circuit, as at A—just a capacity and an inductance. A double-reading wavemeter may be made with two coils and a switch, as at B.



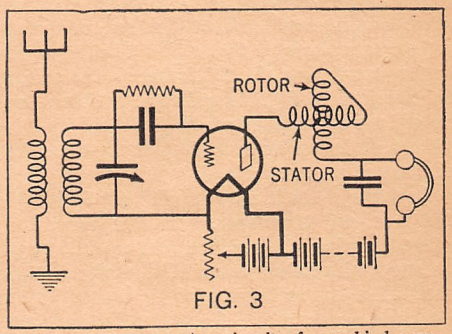
Here is the way the readings with a coil and condenser used by the author worked out on paper. The squares with which the paper is ruled are omitted in the reproduction.

With the broadcast receiver thus tuned, put on the headset of the short-wave set and adjust this to listen for the short-wave harmonics, say, at 30 meters. This method requires the knowledge of the wavelength of one station somewhere in the range of the receiver. W2XAL, RADIO NEWS' short-wave broadcasting station, operates at 30.91 meters; W2XAF, Schenectady, at 31.40. Any receivable station may be used for the calibration, if its wavelength is known.

In this discussion, W2XAL, the RADIO NEWS short-wave station, will be used as an example. Its wavelength is actually 30.91 meters; but, to simplify the figures, its wavelength will be assumed to be an even 31 meters. Of course, any short-wave station, convenient to the listener, can be used. With the prepared table of harmonics (note that it is often more convenient to use a particular station because its harmonics may come closer to the wavelength of the short-wave station used than another) tune in the short-wave station, the wavelength of which is known. In the tables given, the twelfth harmonic of station "X" is 30.10 meters and the short-wave station tuned in, has a wavelength of 31 meters; consequently a harmonic of the broadcast station will be heard somewhat below the wavelength of the short-wave station and it should be found easily. If the station tuned in on the broadcast set is not too weak, or the coupling between the broadcast receiver's secondary and the short-wave tuner is not too loose, the harmonic will be found easily.

MOVING OVER THE SCALE

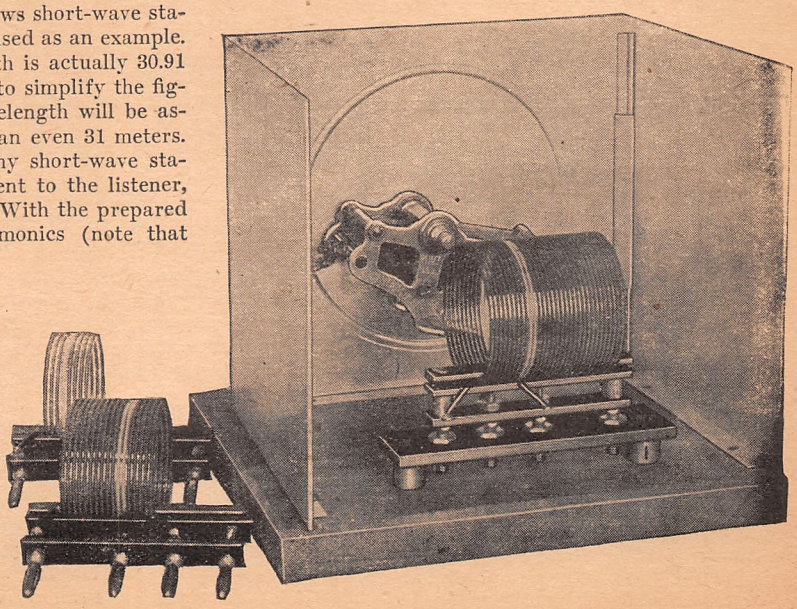
Suppose, for simplicity, that it is necessary to turn the receiver-dial over one degree in changing from the short-wave station to the broadcast station harmonic; the difference in wavelength between the harmonic (30.1 meters) and the short-wave station (31.0 meters) is about a meter, so that one degree on the receiver dial represents one meter. Obviously two degrees will be about two meters, etc. The next harmonic in the table for station "X" is 27.78 meters, or roughly, two meters (representing two dial degrees) lower on the receiver, so this harmonic is also found easily.



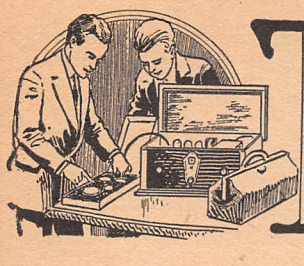
A simple regenerative circuit of any kind may be used; that of Fig. 3 is suggested. It picks up and amplifies station harmonics as well as the carrier frequency.

Use a "coupling" distance of about one foot to start with, and tune in a good powerful station. After becoming familiar with the method, one can try other values of coupling, and other stations. The harmonics

(*Continued on page* 1038)



Wavemeters cannot be shielded entirely; as the coil is the only pickup they have.



The Service Man

"A"-Supply Condenser Clears Up Speaker Hum

Editor, RADIO NEWS:

I have found that the usual type of dynamic speaker, which operates from the A.C. line with a step-down transformer and dry rectifier, produces a very noticeable hum. In several cases, I have found that the use of a high-capacity condenser, such as those made for "A" power units, will reduce the hum so that it can hardly be heard. The condenser is connected across the terminals of the field coil of the speaker. These condensers are usually *polarized,* and it is necessary to connect them in the correct way. The easiest way, I have found, is to connect a voltmeter across the field coil and note the direction in which the needle moves over the scale. (*It is necessary to use the correct type of meter for this purpose, since some meters read correctly when connected either way across the coil. The type of meter employing the D'Arsonval movement is polarized and quite suitable.*) When the polarity of the current in the field coil is known, it is a simple matter to connect the condenser across the coil.

In some cases it may be difficult to locate the field-coil terminals. In this case, the wires running from the rectifier unit may be used, since they connect directly to this coil. The connections of the usual type of dynamic speaker are shown in the enclosed diagram (Fig. 1). The high-capacity condenser is marked C.

GEORGE MILLER,
Des Moines, Iowa.

Interference Filter Units

Editor, RADIO NEWS:

While testing and repairing radio sets, I often encounter interference picked up from power lines. I have found that the suggestion, given in RADIO NEWS some time ago, of connecting two filter condensers in series across the supply line, with the center tap grounded, is very useful in reducing these noises; but I believe that a better filter could be built, which will cause a greater reduction in the noise. Can you assist me?

F. MEYER,
Long Island City, N. Y.

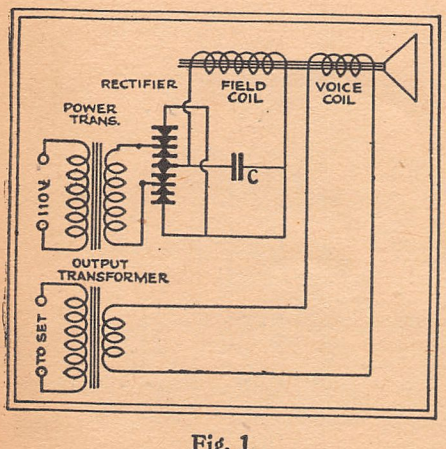


Fig. 1

The "residual hum" of the 6-volt dynamic unit may be conquered by the use of an "A"-unit filter (C), of 2,000-mf. capacity or more.

Electric receivers often pick up from the power lines noises which are generated by apparatus connected to the same or adjacent lines. They are caused also by defctive ground connections in the lines or apparatus. Every power line should be grounded on one side and, in some cases, it has been found that there is no true ground at all; or there is a ground connection which is satisfactory for the low-frequency current in the line, but has a relatively high impedance to high-frequency currents. These points all contribute to the noises in the set but, by providing a low-impedance ground for the high-frequency currents which cause the interference, they are reduced very much.

SERVICE MEN are invited to send in the "wrinkles" and ideas they have found valuable in daily work. All servicers are not old-timers, nor are all equipped with the complete apparatus to make work easy; so that what seems too simple or too laborious to one may not be so to another. This department is especially for the man who works with sets which others have built; as our other pages are for those who build their own. Accepted articles will be compensated, if short, in the same way as other Wrinkles; if longer, at the regular space rates. What have you found out in your daily work that will be for the good of the servicing fraternity?

The disturbance may appear as a mere noise, or it may be noticed as a loud hum or a crackling either steady or intermittent, depending on the apparatus or the source of the disturbance. (This does not mean that all humming noises are caused by defective lines.) As a rule, the disturbances affect the operation of the set, in addition to creating noise, and the symptoms are usually as follows:

The detector tube is quite sensitive to body capacity; that is, a loud hum is heard when an ungrounded piece of metal or the observer's hand is placed near the detector tube. The detector tube is usually very microphonic.

Disturbances in the power lines should, if possible, be taken care of at the source; but in many cases this is not practical for obvious reasons. The only other logical way of overcoming the trouble is to place a suitable filter in the line feeding current to the set. The filter should be constructed in such a way that a good high-frequency ground is provided for the power line. Such a filter consists of two 1- or 2-mf. condensers, with a working rating of at least 400 volts, connected *in series* across the power line with their center connection grounded. This is the type of filter which has been described in several back issues of this magazine.

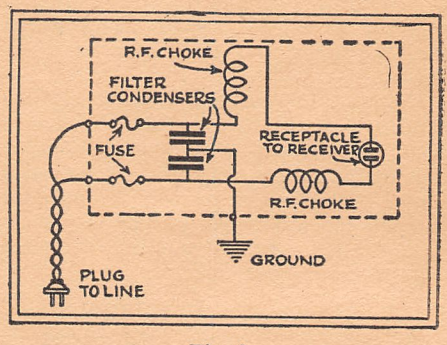


Fig. 2

The essential circuit of the interference filter is shown above. The condensers absorb high-frequency impulses, while placing very little load on 60-cycle current.

The filter may be improved greatly, in many cases, by connecting two air-core chokes in the line, in series with each lead to the set. Because of the comparatively large current passing through these choke coils, ordinary receiving-set choke coils cannot be used. They must be made of heavy wire, the gauge depending on the amount of current consumed by the set. Suitable coils can be wound with 50 turns or more of number 14 or 16 D.C.C. wire on a wooden or fiber form about 2 inches in diameter.

The complete filter should be mounted in an iron cut-out box of the type used to house fuses and other apparatus used in the electric-light line. Two fuses of about 3 or 5 amperes capacity should be connected in the line also, to protect the set in case of short circuit in the filter or in the line. The complete filter, in its metal box, should be placed as far away from the set as the installation permits, and a very good ground should be provided. When mounting the choke coils, it is advisable to place them at right angles in the box, so that they will be out of inductive relation to each other. The diagram of the complete unit is shown in Fig. 2.

Adjustable Capacity Bank

Editor, RADIO NEWS:

In experimenting with new circuits and improving old ones, there is always a need for fixed condensers, which must be of a certain capacity for best operation. To find the correct value is a task that often causes much inconvenience and grief; especially if the changes must be made while the set is in operation, so that the change or improvement can be noted. To overcome any trouble which might result is a very simple matter and requires very little time and effort. The

necessary parts for the construction of the "capacity bank" may be found in almost every experimenter's junk box.

ALBERT A. KENYON,
Santa Monica, Calif.

EDITOR'S NOTE: The unit as it was originally received employed a tap switch of the type used extensively some years ago for tapped coils. In order to make the unit more useful and simpler to build, we have changed the design slightly. A fan-type switch, capable of covering all the switch points, is employed.

The unit consists of a number of fixed condensers of different capacities. These condensers are switched in and out of the circuit, or used in groups, to supply a variety of capacities. The construction of the fan switch is shown in the accompanying illustration. An ordinary knob (such as those used for rheostats, etc.) is fastened to a piece of spring brass, cut as shown. One side is sufficiently wide to cover all of the switch points (in this case 6 are used) and the opposite side is cut so that either one or two points, only, are covered at one time. The switch points should have the lowest top or shoulder available, so that the switch blades will pass smoothly over them, making a good wiping contact.

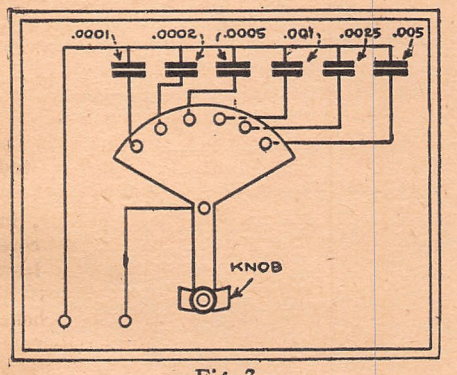


Fig. 3
A variable-capacity bank is convenient for testing purposes. The fan-switch arm shown gives a wide range of values.

A panel about 5 inches square is required to mount the switch and other parts. The condensers are sufficiently supported by the wiring to the switch points. The suggested values are as follows: .0001-mf., .0002-mf., .0005-mf., .001-mf., .0025-mf., and .005-mf. These condensers are connected as shown to the various switch points.

With these condensers, 18 individual capacities may be obtained. With the switch arm covering two points, a capacity of .0003 mf. can be obtained by touching the first two taps. This places the .0001 mf. and the .0002 mf. condensers in parallel. Similarly, capacities of .0007, .0015, .0035 and .0075 can be obtained by moving the switch arm over to cover the succeeding pairs of switch points.

By reversing the position of the switch, so that the fan switch-arm is used, capacities of .0008, .0018, .0043, and .0093 are obtained, by moving the arm over to cover additional taps. With a capacity of .0093 mf. the fan switch-arm will be directly over all of the switch points. If it is moved further to the right, the first switch point will be uncovered and this will reduce the capacity by .0001 mf., leaving a capacity of .0092. Similarly, by uncovering the two on the left, a capacity of .009 will be obtained. With the three left taps uncovered, a capacity of .0085 results. The next move to the right repeats the capacity of .0075 which has been obtained already.

The complete series of capacities available with the unit are as follows: .0001, .0002, .0003, .0005, .0007, .0008, .001, .0015, .0018, .0025, .0035, .0043, .005, .0075, .0085, .009, .0091, .0093 mf.

The uses of these conveniently available capacities will suggest many uses to the wide-awake service-man and dealer. One very obvious use is in audio-frequency amplifier testing and repair. A fixed condenser of the correct size will often stop the annoying whistles produced by audio feedbacks, etc.; and the use of the correct fixed condenser connected across the coupling transformers in an amplifier will often produce a great improvement in the sound quality.

Adapting Old Sets for Power Tubes

Editor, RADIO NEWS:

I wish that you would furnish me with a hook-up of the No. 12 Atwater Kent 6-tube set; also a hook-up for a power tube to be placed in this set.

SGT. A. J. GOETZ,
Fort Brown, Texas.

Since the manufacturer of this set does not wish to have the diagram of the set published, and copyrights it, we cannot print the diagram of this receiver. However, the addition of a power or semi-power tube to any set is quite simple and, since it should be of interest to a great number of younger custom set builders and repair men not familiar with the methods of doing this, we are giving instructions here. They are not limited to this particular set, but are equally applicable to many old-style receivers.

The upper diagram in Fig. 5 shows the connections found in the set before the changes are made; X and Y in the diagram indicate the two points at which changes must be made. It will be noticed, that the speaker binding post connects to "B+ 90" lead in the set, and the lead from the secondary of the last A.F. transformer is connected directly to the "A—." In some cases, the transformer is connected to the negative terminal of a "C" battery; but the changes

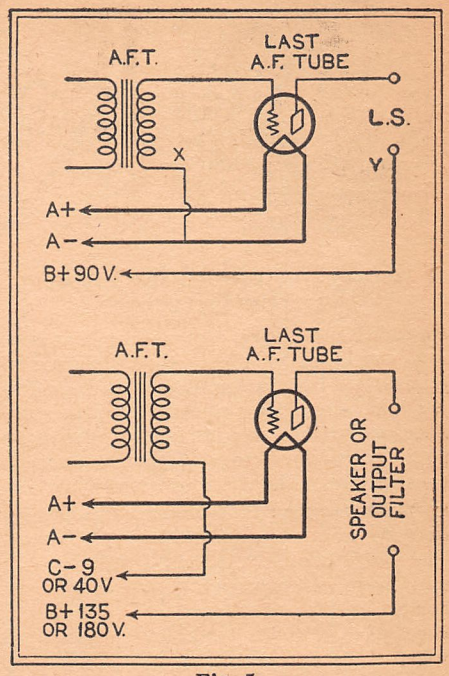


Fig. 5
It is easy to put a power tube in one of the old-style sets which use a 201A, in the manner shown, and effects a big improvement.

are the same with this method of connection, and the instructions apply equally well in both cases.

In the lower diagram is shown the same amplifier, changed to include a power tube. The speaker wire is disconnected from the "B+90" terminal, and connected to a new wire; which is in turn connected to "B+135" for a 112A-type tube, or "B+180" for a 171A-type. The return from the transformer secondary is also disconnected from the "A—" or the "C—" of the previous A.F. stage, and instead connected to a wire which is attached to the "—" terminal of a "C" battery; 9 volts for a 112A or 40 volts for a 171A tube. The "+" terminal of this "C" battery is, of course, connected to the "A—" terminal in the set, in order to complete the circuit.

When a power tube is used in a receiver,

(*Continued on page* 1032)

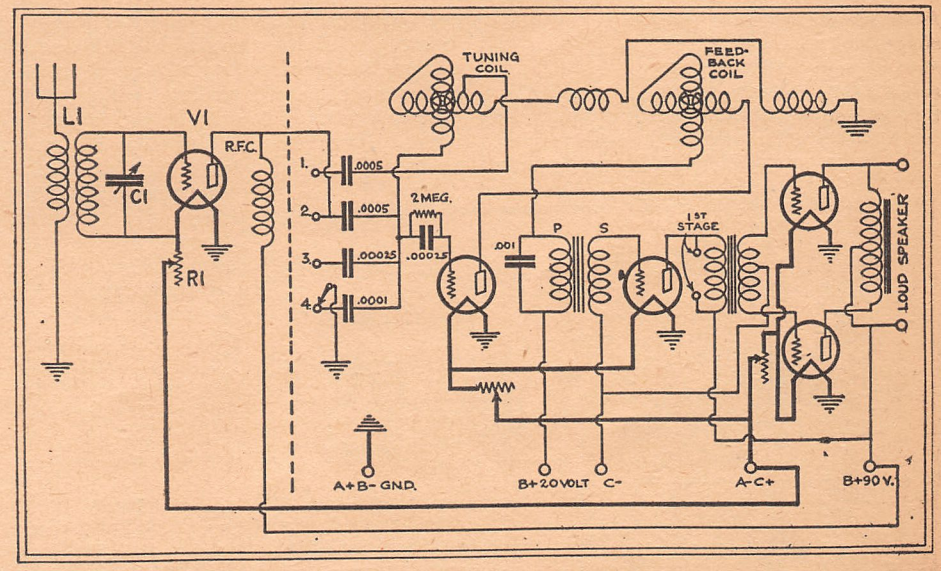


Fig. 4
The Radiola IIIA (at right of the dotted line) was once the best going, and there are many in use. They are, however, radiating sets; the owner who can be prevailed on to add a tuned stage, as shown, will eliminate this feature and gain selectivity and range.

Applying an Audio Filter to the Detector

ALTHOUGH "B" power units have been developed to a very high standard of efficiency, a hum is encountered in some few cases and demands a remedy. A rather unusual use of a "tone filter" has been made by one fan in reducing this hum to a much lower value. The filter was originally designed to be connected between the output of the set and the loud speaker, to keep the plate current out of the speaker windings. The choke coil in the filter was rated at 30 henries, and a 2-mf. filter condenser was connected in one of the leads as shown. Three of the leads were used, as indicated in the diagram (Fig. 1).

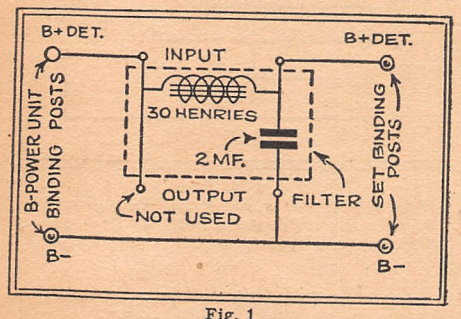


Fig. 1

The same system which separates the plate current of a power tube from the output signal may be used in a detector circuit.

If a hum is encountered, after the filter is added to the regular filter of the power unit, it is evidently caused by an inductive pick-up in the wiring of the set and power-unit, and can be overcome only by proper separation of the offending leads. The filter increases the filtering action only in the detector tube, but this is the usual point at which a hum is encountered. The filter will have no effect on the operation of the amplifier stages.—*Contributed by William C. Duer.*

An Ingenious Speaker Switch

IT is often found desirable to compare the operation of several loud speakers; and this can be accomplished conveniently only by some switching arrangement, which will allow rapid change-over from one speaker to the other. A suitable switch for the purpose may be made as shown in Fig. 2.

It is constructed as follows: take a block of wood, say 4 x 7 inches, and ¾ inch thick; and bore into it a hole about ½-inch deep, and just large enough to receive the base of an old tube. (The hole should be just deep enough so that the pin on the side of the tube base will be close above the surface of the board.) Then, bore the hole the rest of the way through the board with a smaller drill; one of such diameter that the four prongs of the tube will project through the other side of the board. A shoulder, for the bottom of the old tube base to turn on, is thus formed.

Next drill two rows of small holes, in a semi-circle; one row for the red and one for the black phone-tip jacks. Scribe all around the tube-base hole in the board a circle about an inch larger than the hole. On this circle are located the contact points, which may be ordinary wood-screws or machine-screws fastened on the upper side. The brass contact plate also is located on this circle; it is made of a piece of brass sheet cut in a semi-circle and is as long as the distance between the outer contact points. Small holes are drilled in the ends of the plate for mounting with wood-screws.

Our readers are invited to contribute ideas. A year's subscription to Radio News *will be given in compensation for each accepted item. If the author of the wrinkle is already a subscriber, his subscription will be extended one year or he may accept a one year's subscription to* Science and Invention *or* Amazing Stories, *both issued by the same publishers.*

The contact arm is made of spring brass, just heavy enough to give the correct spring action. Two holes are drilled in this arm, one for a large tube-prong (one of the filament prongs) and the other for a small prong. The contact arm is bent until it presses tightly against the contact plate and the contact points; then it is secured to the tube-base by soldering it to both the large and small prongs over which it fits. The phone-tip jacks are wired as shown, and the wires secured to two terminals, or to a phone cord, for connection to the set.—*Contributed by L. W. Moyer.*

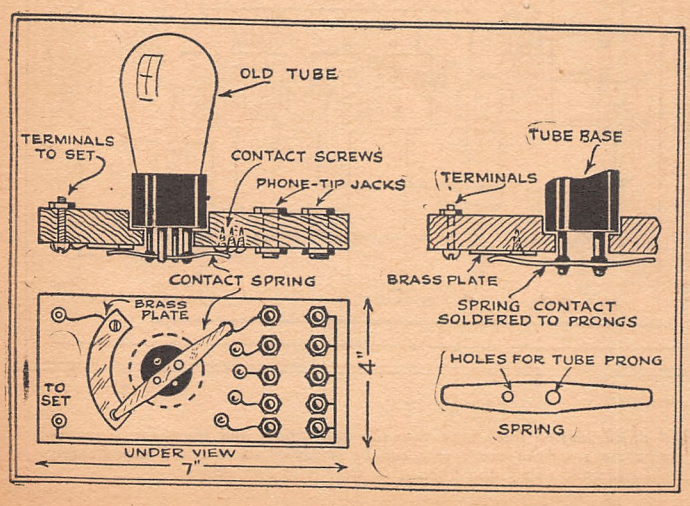


Fig. 2

The contributor of this wrinkle has found another use for the burnt-out tube—it serves him as a handle for a five-point speaker switch.

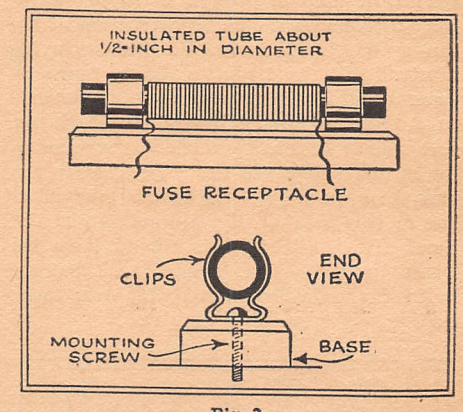


Fig. 3

A choke coil that fits in a fuse mounting permits handy substitution of different values.

Making Short-Wave R.F. Chokes

CHOKE COILS, suitable for short-wave receivers, may be made at home and serve their purpose satisfactorily. It will be found, however, that a different coil will give the most satisfactory results for each waveband, and it may be necessary to try a great many in order to find the best for use with each tuning coil. For this reason, the experimenter will find it most convenient to mount the coils so that they may be used interchangeably; a plug-in mounting is the handiest device for this purpose.

An easily-built plug-in receptacle, employing cartridge-type mountings, is illustrated in Fig. 3. It is preferable, of course, to use a mounting designed for fuses of the larger type. As a form for the coil, a burnt-out fuse may be employed, or a piece of glass, porcelain or even cardboard tubing of suitable size will serve. To prepare the latter, it will be necessary to solder around each end of the tube a piece of copper or brass to make contact with the mounting clips and, of course, with the coil terminals. If space permits, the coils should be wound single-layer, or solenoid. Fine wire, such as No. 30 enamelled, should be used, so that there will be room for a sufficient number of turns.—*Contributed by James S. Berry, W4AJQ, Saltillo, Texas.*

A Short-Wave Dial Log

THE popularity of short-wave receivers has brought up a number of new problems rarely encountered in the operation of broadcast sets. One of these is the extremely fine tuning required, and the difficulty in picking up the station again after it has been turned out. If the dial settings are marked directly on the dial, this difficulty is partly overcome. At least, the

exact dial setting is known and, if the station is "on the air," it can probably be picked up with little trouble.

This method of calibrating the "Junk-Box" set will help the builders of this set to tune their receivers. Take a large piece of paper or several sheets (anything that the constructor thinks will suit him) and with a pair of dividers draw five half circles to represent the dial of the set. Then number these to correspond with the sets of coils, one division for each. (See Fig. 4.)

Now, whenever a station is received, record the call letters opposite the number on the paper dial which corresponds to the coil which you are using. In this way you will determine the range of each of the coils, as well as the exact location of each station. The paper dial should be made to correspond in size to the regular dial, and should be pasted over the latter.—*Contributed by John Hayden, Jr.*

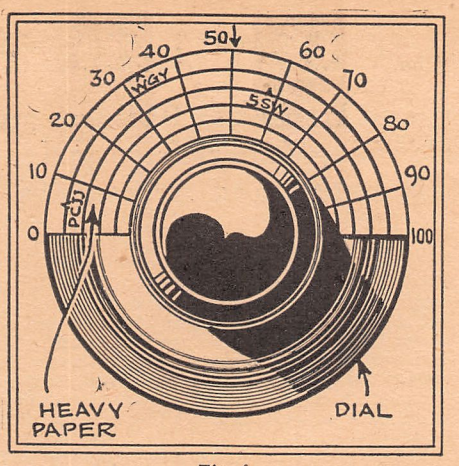


Fig. 4

A plain dial for a junk-box set will carry a log for sets on several wavebands, as shown.

Simple Screen-Grid Shielding

CONSTRUCTORS who, in their experiments with the screen-grid tube, have found shielding absolutely essential for best results, will appreciate this wrinkle, which is extremely simple and yet makes as good a shielding job as can be done with more elaborate material.

It is simply a matter of wrapping the tube to be shielded with heavy tinfoil or leadfoil. This is held in place with shellac or a similar preparation. When curving the foil about the top of the tube a much

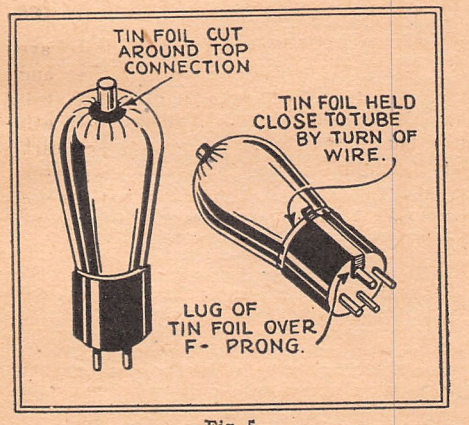


Fig. 5

It is necessary to shield the elements of a screen-grid tube, capacitively at least.

neater effect may be obtained by slitting the foil to avoid wrinkling. A lug is left at the bottom to fit over the "F—" prong of the tube, thus grounding the shield. Care should be taken to cut out sufficient foil about the cap of the control-grid to avoid grounding it.—*Contributed by Charles E. Hammer.*

Guitar's Loss is Radio's Gain

WHAT may be considered a musical addition to the radio receiver is submitted by a reader who experienced some difficulty with the control cord of a drum dial. After assembling the components of his receiver he found that, because of the loosening of the cord on the drum, it was constantly slipping off. This necessitated a complete disassembling of the shielded tuning units, in order to get at the drum so that the string could be replaced.

After the second operation of this nature it was found (after some computation) that the time consumed would have been sufficient to construct another receiver of similar design, or thereabouts. A guitar's "G" string solved the problem when it was substituted for the recalcitrant string.—*Contributed by A. Dolid.*

Making the Panel Repeat

HERE is a "wrinkle" from a constructor who prefers to employ one panel for a number of experimental circuits instead of purchasing a new panel for each circuit. He recommends for this purpose the material ordinarily used for auto tops and cushions.

After the material has been cut to the size of the panel, it is glued on and the new holes are drilled after the glue has dried thoroughly. The material, which can be obtained in numerous patterns and colors, not only covers up the old holes in the panel but makes quite an artistic looking job. A dollar's worth should be sufficient for a dozen panels.—*Contributed by Merrill Johnson.*

Reversing an Old Wrinkle

BUILDERS of the "Junk-Box," and similar short-wave sets using tube bases for the coil forms, often find that they do not have sufficient burnt-out tubes for the coils. In some cases, friends can be prevailed upon to part with theirs; but, when unsuccessful in thus obtaining the necessary obsolete tubes, one fan devised the ingenious method of reversing the plug-in arrangement. Sub-panel sockets are not very expensive and provide the necessary answer to the question. Instead of using tube bases for the coils, the latter are wound on cardboard tubes of the correct size. A tube socket is fastened to the bottom of the coil, and this is plugged into an old tube base which is fastened to the sub-base or sub-panel. In this way, only one tube base is required, while one tube socket is used for each of the coils. The terminals of the coils are fastened to those on the tube socket; this facilitates the construction of the coils. The tube base is readily mounted by drilling a hole in its top, between the prongs and inserting a screw through the hole.

Cardboard tubes taken from flashlight cells make excellent coil forms.—*Contributed by Wilbert L. Misner.*

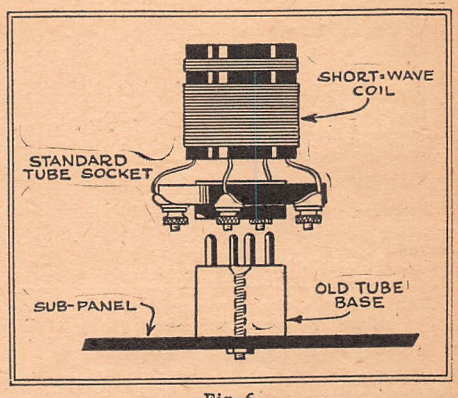


Fig. 6

This wrinkler, strange to say, had more sockets than burnt-out tube bases on hand.

A Flexible Primary Coupling

IN some of the latest receivers, provision is made for varying the primary with relation to the secondary coil. This affords a very distinct advantage, as the selectivity of the receiver can be better adapted to the conditions under which the set is used. In a city where there are powerful broadcast stations, the receiver must be very selective, in order that it may successfully separate one station from the others. In the country, on the other hand, the set is usually located at some distance

(*Continued on page* 1047)

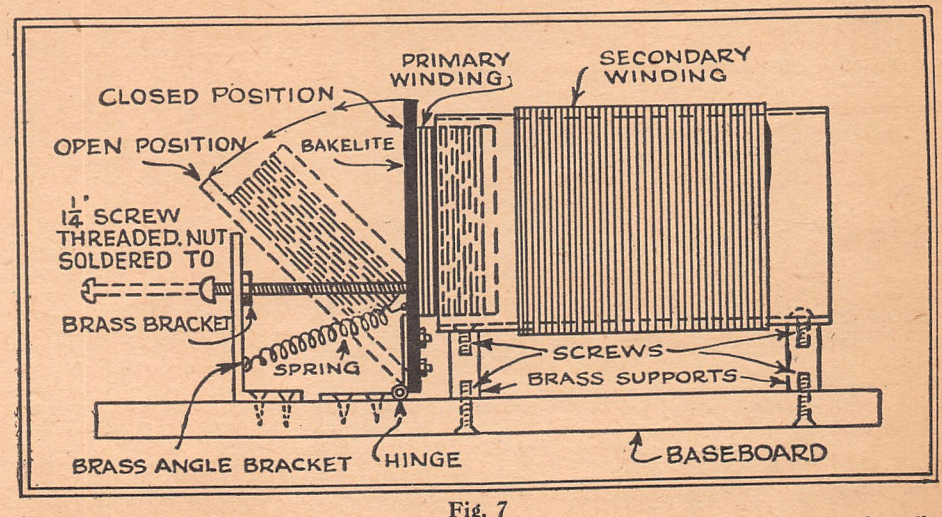


Fig. 7

That different locations require different compromises between selectivity and sensitivity, is well known. The method shown permits the constructor to determine the exact point of best operation for any given location of his set. The closed position above gives signal strength, the open position sharper tuning.

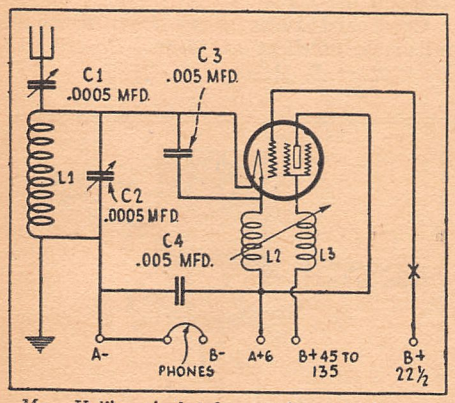
The Radio Constructor's Own Page

Wherein Custom and Home Set Builders and Experimenters All Over the World Swap Experiences and Suggestions About Hookups and Accessories

TURNING THE 222 INPUT-OUT

Editor, RADIO NEWS:

In your October number you stated that you would like to hear from experimenters with the idea of filament input and grid output. I have had very good results, not with the 199s and 201As as described, but with a Cunningham 322. The circuit shown seems to be equal to or better than the standard regenerative set. As for volume, on most nights WCSH, WBZ, KDKA, WPG, WBAL, etc., are too loud to be agreeable, with two sets of headphones in series. I can usually separate KDKA and WBZ completely; which, considering their location and power, and my location with respect to them, is all that can be asked and more than one should expect. I am convinced that a non-inductive rheostat and potentiometer control of bias and "B" battery would be of considerable advantage.



Mr. Hall's single-tube receiver employs a screen-grid stage in unusual fashion.

The bias on the plate of this tube, here used as the grid, is positive. The voltage on the screen-grid, here used on the plate, may be anything up to 135 volts. The voltage on the inner grid (regular control-grid) may vary from one-third to two-thirds of the plate voltage. There is a best value, but it is in no sense critical.

The voltage of the "A" battery should be from 4 to 6; as it must overcome the resistance of the coils L1 and L2. A voltage slightly less than normal, however, is needed across the filament. Too much current here will cause the set to operate poorly, or not at all.

The rheostat setting is quite critical, and varies slightly when "B" voltages are changed. The phones may be placed as usual between the tickler and "B+," a by-pass condenser making but little difference. Some body capacity may be experienced with phones here; but none will be found when set is properly tuned when they are placed between "B—" and either "A+" or "A—." The phones are now common to both plate and control-grid circuits and this sems to give a little more volume.

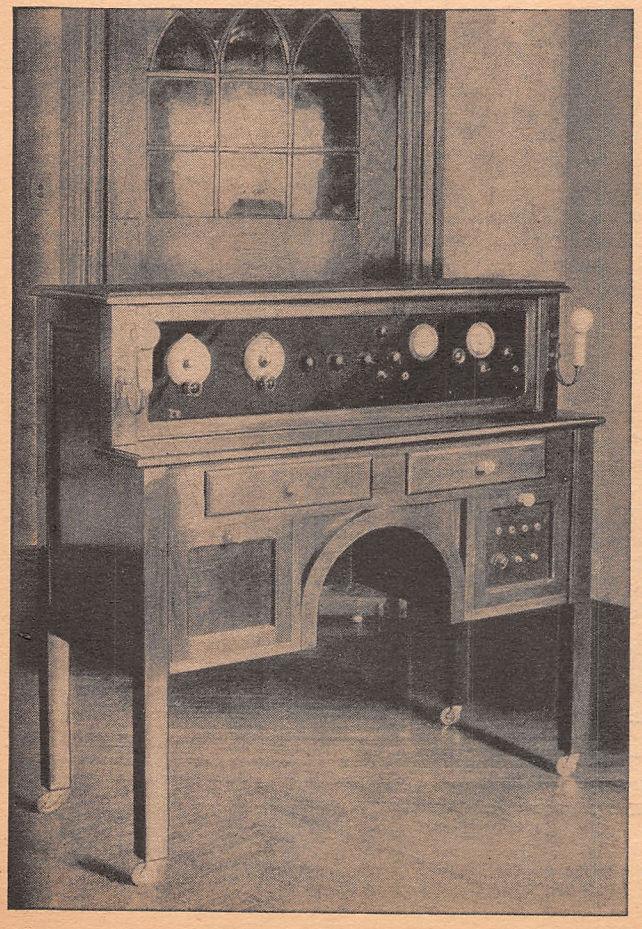
The set is in proper condition when a sound like escaping steam is heard. A loud, but regular beat or note, varying in frequency with the movement of the tickler, may be heard when the set is in this condition.

To tune, set C1 about right, and use C2 and tickler as in any regenerative set. Use any aerial of thirty feet or more.

I use spiderweb coils, 5-inch diameter, 50 turns of No. 22 on each. Coils L1 and L2 may be placed in almost any inductive relation, so long as they do not neutralize each other. L1 and L2 are placed in the same plane edgewise, 8 inches center to center. L2 and L3 are parallel, edge of L2 to center of L3, and variable from ½ to 6 inches apart. The width of the band covered, selectivity and volume will vary considerably with the different positions. A second tickler might be added in the "B+22½" circuit, and in variable inductive relation to L1.

GEORGE F. HALL,
Center Barnstead, New Hampshire.

(Mr. Hall's circuit is certainly different from anything yet presented. It may be of interest to the constructors who are ready to try anything once. It is presented here purely as a basis for further experiments.



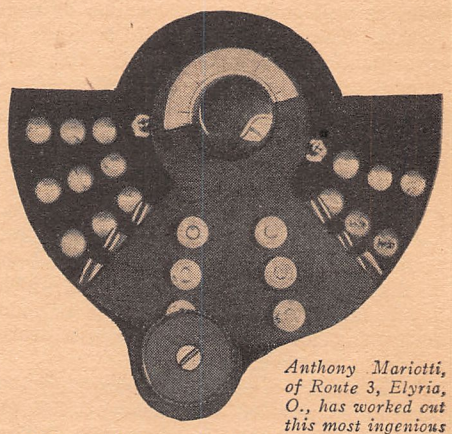
It seems to us that there is an ecclesiastical air about this very substantial piece of radio furniture. Possibly that is because it was constructed for the Rev. J. W. Bittner, pastor of St. John's Lutheran church, Kutztown, Pennsylvania, who used it to house the Strobodyne receiver which he built. It was designed by Mr. Bittner and built of walnut. Mr. Bittner sent in the photo; inquiring the feasibility of using a screen-grid R.F. stage in this receiver. This can be done with the mere change of the R.F. coupler to use a primary giving higher impedance, and the usual choke-coil and by-passing arrangement.

A FANCY HORN

Editor, RADIO NEWS:

With regard to my horn, illustrated by you in the April issue of your magazine, here is some more information.

The diameter doubles at equal intervals of 22 inches. To those who are familiar with the slide rule, figures for an exponential horn are easily obtained. Use 602 on scale of equal parts, and divide this figure by the number of inches you wish each interval to be; and then calculate the same as compound interest.



Anthony Mariotti, of Route 3, Elyria, O., has worked out this most ingenious multiple switch for coil changing. The workmanship is very precise.

I chose battleship linoleum as a liner, because of its deadness to vibration, thickness, smoothness, flexibility and ease of working. The ribs, of which there are 75, are made of dry sugar pine, cut on a bandsaw and sanded to a hairline. Each rib is made of four pieces glued and screwed together; otherwise it would have taken an 8-inch board to make each rib. They are sawed straight on the outside and follow the exponential curve on the inside, to simplify the making.

Up to where the horn is 12 inches in outside diameter, it is made of solid timber, cut in sections four inches long and turned in a lathe to the dimensions corresponding, with an allowance of .006-inch for the thickness of the paint (ivory enamel). These sections are turned with male and female joints, and then glued together. A long bolt is run through the center of the horn, and then tightened up.

The first interval of 22 inches is made of heavy zinc, .045-inch thick, which has a brass flange on the large end to fasten to the wooden section, and a piece of brass threaded and soldered to the small end to receive the unit. The latter is a Utah De-Luxe which has an 11/16-inch opening.

AL. MORRISON,
81 *So. Sherman St., Denver, Colo.*

(Few readers will have the equipment to attempt duplicating Mr. Morrison's fine work. As for calculating size of an exponential horn, the June 1928 issue of RADIO NEWS *contains rules for determining the diameter of different sections with the aid of simple arithmetic.*—EDITOR.)

GROUNDS VS. AERIALS

Editor, RADIO NEWS:

Radical as the statement may seem, I am forced to the conclusion (and my opinion is confirmed therein by clear, distinct reception night after night of all local stations within a radius of twenty miles) that the aerial is superfluous and is only, in fact, a poor ground.

In the room in which I operate I have two pipes making ground connections; one a gas pipe and the other a water-supply line, both ¾-inch. By simply connecting the set terminals with these two pipes, better reproduction is obtained than when the aerial is used. I mean just that; when the aerial is cut in there is a material drop in volume. It would appear, therefore, that the real transmission of radio waves is through the ground and such as are picked up on aerials are merely

emanations from this ground current. (*Several of our readers who have obtained good reception on ground alone have expressed the theory that radio waves travel "the low road" and come up instead of down, into the set from the ground. It might be hard to square this with the excellent reception which has been obtained on aircraft high in the air and having no connection with the earth.*—EDITOR.) Apparently these currents, following the path of least resistance—the earth itself being inferior as a conductor to iron—strike the separated pipes and are conveyed thereby through the set; and the use of an aerial, in place of helping them, impedes them to a certain extent.

This is not a matter of freak reception for one night, but of continuous reception. I have noted that, on connecting one of these grounds directly to the aerial—so that I have on one side a direct ground, and on the other a combined ground and aerial—changes the reception not the slightest; but the moment one of the grounds is disconnected, the volume drops appreciably.

I wish it were possible for me to do some experimenting in transmission; for I would like to know what the effect of transmitting directly into the ground without an aerial (at two points some hundred or so feet apart) would be.

The set used is of the simplest construction. Forty turns of No. 18 D.C.C. wire on a tube 4 inches in diameter, 5 inches long, tapped on each 10th turn and controlled by a 4-point inductance switch; a 23-plate variable condenser, a .005 fixed condenser and a fixed Carborundum detector.

H. J. WALTERS,
Box 670, Havana, Cuba.

(*It is obvious that the phenomena described do not agree with the perfect-ground theory. The set operates on the difference of potential across two metal systems, separated some distance; and which are separated by a considerable resistance.* (*See the article on "Short-Wave Aerials and Grounds," in last month's* RADIO NEWS.) *In the tropics, atmospherics or "static" are far more intense than in northern regions; and the advantages of a buried aerial are more pronounced. In addition to this, it is quite possible that one or both pipe systems have an insulating joint between house and street. Mr. Walters uses a simple crystal set; a receiver with tubes, and consequently an electrical supply, should never be connected to a gas pipe. However, it goes to show that you can't tell what is the best antenna system in your location till you have tried. We are often asked, "What is the best antenna to use with my set?" That is a question which cannot be answered at long range. As for transmission, where high power is involved, there would certainly be a considerable loss of power between the two lines. A transmitting aerial is strung as high and clear of surrounding objects as possible, to increase its "effective height," and consequent range.*—EDITOR.)

"BLOOPLESS" ALTERATIONS

Editor, RADIO NEWS:

I have built the "Bloopless" one-dial set, out of spart parts, and wish to state that, properly built, it can't be beat. Using only a 25-foot inside aerial, it has brought in KNX, KFWB, KPM, KFI and KOA; this by plugging in its output into the audio amplifier of my five-tube set through a tube-base adapter. I had KRLD, Dallas, yesterday morning until they signed off at ten o'clock.

I made a change that I want you to pass on. Instead of using the 100,000-ohm antenna resistor, I used a home-made choke coil. It contained about a hundred turns of No. 26 enamelled wire in a ½-inch slot in a spool (¼-inch core) jumble-wound. With an aerial not over forty feet in length, this coil peaks at about 500 meters, with a consequent amplification almost equal over the broadcast band. Also, instead of an 8-turn primary on the three-circuit coil, I used one of 25 turns. In this locality such a large primary does not cause too much lack of selectivity. Also, I use a CX-300A detector tube in the first stage, instead of a 301A.

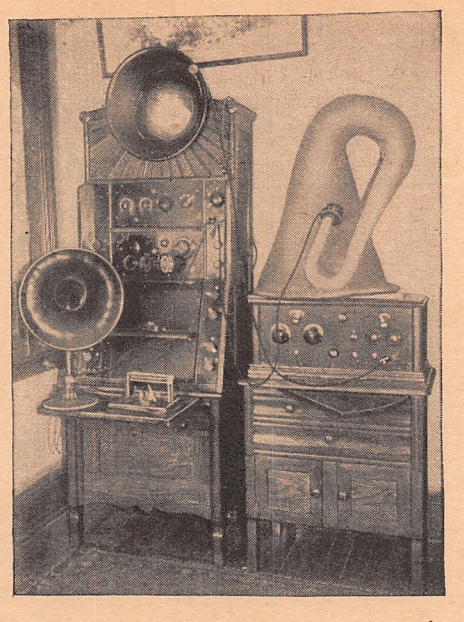
T. H. MILLER,
c/o C. & W. C. Ry., Greenville, S. C.

AN EXPERIMENTER'S CONSOLE

Editor, RADIO NEWS:

I have made a large cabinet with four panels 7 x 16, as shown in the photo, for experimenting. It is very handy to change hook-ups, but rather unhandy to change plug-in coils. So I plan to wind short-wave coils up to 90 meters on 1½-inch tubes and from 90 meters up to 2-inch coils, and mount them on a turntable with bevel gears; so that I can change from one to the other by turning a bevel gear with a knob on the panel.

The panels slip into the cabinet on shelves, and connect to the wiring, the same as a Ford coil box.



Mr. Harrington has a very compact experimental layout, as appears above. It is designed to promote interchangeability of sets.

LOUDER HARRINGTON,
319 Pennell St., Chester, Pa.

A FINE COMBINATION

Editor, RADIO NEWS:

I built the entire console shown in the photograph (reproduced below), receiver, power amplifier, and all art features shown, in my own workshop. The receiver is an eight-tube superheterodyne, the last tube being a 250 wired in connection with a 450-volt power pack, giving enormous volume with wonderful tone quality. The left side grill conceals the loop; the center upper compartment contains the receiver, with the power amplifier below it; and the right grill the dynamic speaker. I have received all important stations in the United States and Canada with volume and clarity unbelievable to the sceptical radio fan.

The construction of such an elaborate receiver would no doubt tax the ability of the average home set builder; yet it may fit the ambition of some really energetic fan with lots of patience and mechanical ability to tackle a real job.

E. H. REED,
114 West Liberty St., Elgin, Ill.

(*Mr. Reed is evidently not a bit ashamed of his masterpiece. However, on looking it over, we do not blame him. It is evidently a set to be proud of; the more as it is his own handiwork.*—EDITOR.)

WHAT'S IN YOUR CELLAR?

Editor, RADIO NEWS:

Few people realize the importance of a good ground. A special ground installed by me brought in Davenport, Iowa, just as strong as KYW was coming in (at Kenosha, Wis., which is 50 miles north of Chicago) on a water-pipe ground. With a two-tube Harkness reflex I received all stations of any importance from Denver, Ft. Worth, Nashville, Atlanta, New York City, Springfield, Mass., and all on the speaker with good volume. All this is due to the excellence of the ground.

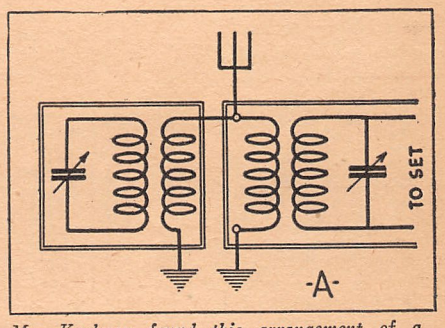
B. R. MEDLEY,
Milwaukee, Wis.

(*The ground system sketched by Mr. Medley comprises a number of copper plates buried in a hole 4⅛ feet deep and 8 inches in diameter dug under the cellar floor. This is just the thing where it is practicable; but we can hardly see ourselves, here in New York, blasting through the steel and concrete floor of the cellar of a 14-story apartment house. However, those more fortunately situated will find a ground along these lines an excellent help. Such grounds have been more than once illustrated in* RADIO NEWS.—EDITOR.)

AN AERIAL TUNER

Editor, RADIO NEWS:

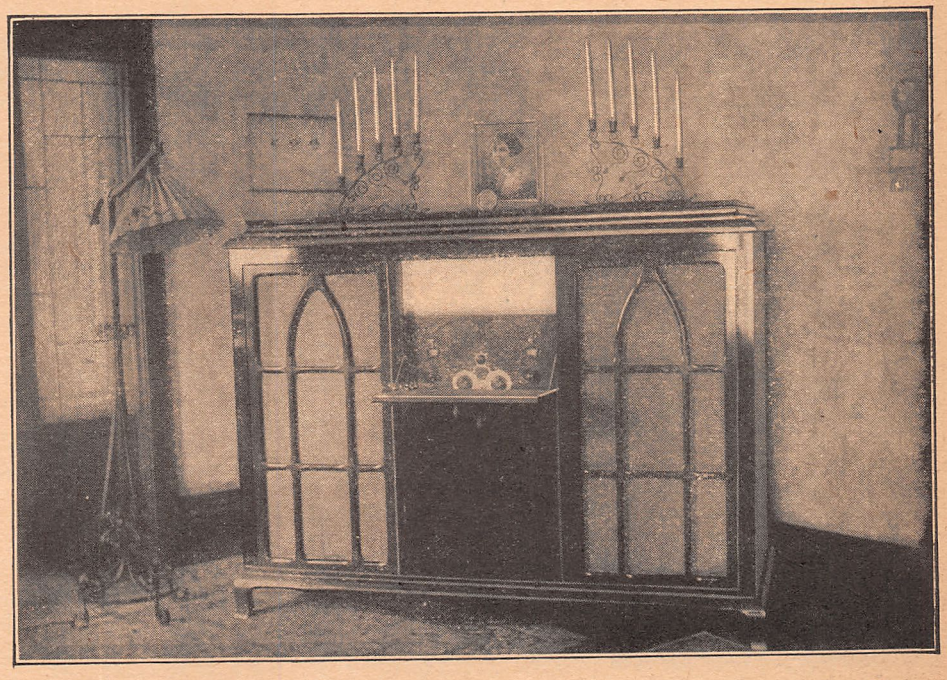
I have been experimenting with the unit shown schematically in Fig. A, and have had the same connected to different sets, both battery and A.C. I find that it increases volume, selectivity and the distance range of the receiver to which it has been attached.



Mr. Keulman found this arrangement of a wavetrap, with a second aerial as described, a device much wanted by his customers.

The unit is made of the following parts: an inside aerial of about forty or fifty feet, one end to

(*Continued on page* 1050)



Mr. Reed's constructional ability includes cabinet-work, undoubtedly. This self-contained receiver has everything, including a loop in the compartment on the left, that could be desired and will excite the envy of the less ambitious.

List of Broadcast Stations in the United States

Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
KCRC	Enid, Okla.	219	50
KDB	Santa Barbara, Calif.	200	100
KDKA	East Pittsburgh, Pa.	306	25000
KDLR	Devils Lake, N. D.	248	100
KDYL	Salt Lake City, Utah	232	1000
KEJK	Los Angeles, Calif.	256	500
KELW	Burbank, Calif.	384	500
KEX	Portland, Oregon	254	5000
KFAB	Lincoln, Nebraska	389	5000
KFAD	Phoenix, Arizona	484	500
KFBB	Great Falls, Montana	220	500
KFBK	Sacramento, Calif.	229	100
KFBL	Everett, Washington	219	50
KFDM	Beaumont, Texas	535	500
KFDY	Brookings, S. D.	545	500
KFEC	Portland, Oregon	219	100
KFEL	Denver, Colorado	319	250
KFEQ	St. Joseph, Mo. (day)	535	2500
KFEY	Kellogg, Idaho	248	10
KFGQ	Boone, Iowa	229	100
KFH	Wichita, Kansas	231	500
KFHA	Gunnison, Colorado	250	50
KFI	Los Angeles, Calif.	468	5000
KFIF	Portland, Oregon	211	100
KFIO	Spokane, Wash. (day)	244	100
KFIU	Juneau, Alaska	229	10
KFIZ	Fond du Lac, Wis.	211	100
KFJB	Marshalltown, Iowa	250	100
KFJF	Oklahoma City, Okla.	204	5000
KFJI	Astoria, Oregon	219	50
KFJM	Grand Forks, N. D.	219	500
KFJR	Portland, Oregon	231	500
KFJY	Fort Dodge, Iowa	229	100
KFJZ	Fort Worth, Texas	219	100
KFKA	Greeley, Colorado	341	500
KFKB	Milford, Kansas (day)	286	5000
KFKU	Lawrence, Kansas	246	1000
KFKX	Chicago, Illinois	294	5000
KFKZ	Kirksville, Missouri	250	50
KFLV	Rockford, Illinois	213	500
KFLX	Galveston, Texas	219	100
KFMX	Northfield, Minn.	240	1000
KFNF	Shenandoah, Iowa	337	500
KFOR	Lincoln, Nebraska	248	100
KFOX	Long Beach, Calif.	240	1000
KFPL	Dublin, Texas	229	15
KFPM	Greenville, Texas	229	15
KFPW	Siloam Springs, Ark. (day)	224	50
KFPY	Spokane, Wash.	216	500
KFQD	Anchorage, Alaska	244	100
KFQU	Holy City, Calif.	211	100
KFQW	Seattle, Wash.	211	100
KFQZ	Hollywood, Cal. (Ltd.)	349	1000
KFRC	San Francisco, Calif.	492	1000
KFRU	Columbia, Missouri	476	500
KFSD	San Diego, Calif.	500	500
KFSG	Los Angeles, Calif.	268	500
KFUL	Galveston, Texas	232	500
KFUM	Colorado Springs, Colo.	236	1000
KFUO	St. Louis, Mo.	545	500
KFUP	Denver, Colorado	229	100
KFUR	Ogden, Utah	219	50
KFVD	Venice, Calif. (Ltd.)	428	250
KFVS	Cape Girardeau, Mo.	248	100
KFWB	Los Angeles, Calif.	316	1000
KFWC	San Bernardino, Calif.	250	100
KFWF	St. Louis, Missouri	250	100
KFWI	San Francisco, Calif.	322	500
KFWM	Oakland, Calif.	322	500
KFXD	Jerome, Idaho	211	50
KFXF	Denver, Colorado	319	250
KFXJ	Edgewater, Colo.	229	50
KFXR	Oklahoma City, Okla.	229	100
KFXY	Flagstaff, Arizona	211	100
KFYO	Abilene, Texas	211	100
KFYR	Bismarck, N. D.	545	500
KGA	Spokane, Wash.	204	5000
KGAR	Tucson, Arizona	219	100
KGB	San Diego, Calif.	220	250
KGBU	Ketchikan, Alaska	333	500
KGBX	St. Joseph, Mo.	219	100
KGBZ	York, Nebraska	322	500
KGCA	Decorah, Iowa (day)	236	50
KGCI	San Antonio, Texas	219	100
KGCN	Concordia, Kansas	211	50
KGCR	Brookings, S. D.	248	100
KGCU	Mandan, N. D.	250	100
KGCX	Vida, Montana	211	10
KGDA	Dell Rapids, S. D.	219	50
KGDE	Fergus Falls, Minn.	250	50
KGDM	Stockton, Calif. (day)	273	50
KGDR	San Antonio, Texas	200	100
KGDY	Oldham, S. D.	250	15
KGEF	Los Angeles, Calif.	231	1000
KGEK	Yuma, Colo.	250	10
KGER	Long Beach, Calif.	219	100
KGEW	Fort Morgan, Colo.	250	100
KGEZ	Kalispell, Montana	229	100
KGFF	Alva, Oklahoma	211	100
KGFG	Oklahoma City, Okla.	219	100
KGFH	Glendale, Calif.	300	250
KGFI	San Angelo, Texas	229	100
KGFJ	Los Angeles, Calif.	211	100
KGFK	Hallock, Minnesota	250	50
KGFL	Raton, New Mexico	219	50
KGFW	Ravenna, Neb.	211	50
KGFX	Pierre, S. D. (day)	517	200
KGGC	San Francisco, Calif.	211	250
KGGF	Picher, Oklahoma	297	500
KGGM	Albuquerque, N. M.	219	100
KGHB	Honolulu, Hawaii	227	250
KGHD	Missoula, Mont.	211	50
KGHF	Pueblo, Colo.	227	250
KGHG	McGehee, Ark.	229	50
KGHI	Little Rock, Ark.	200	500
KGHL	Billings, Mont.	316	500
KGHX	Richmond, Texas	200	50
KGIQ	Twin Falls, Idaho	227	250
KGIR	Butte, Montana	220	250
KGIW	Trinidad, Colo.	211	100
KGJF	Little Rock, Ark.	337	250
KGKB	Brownwood, Texas	200	100
KGKL	San Angelo, Texas	219	100
KGKO	Wichita Falls, Texas	526	250
KGKX	Sandpoint, Idaho	211	15
KGO	Oakland, Calif.	380	10000
KGRC	San Antonio, Texas	219	100
KGRS	Amarillo, Texas	213	1000
KGU	Honolulu, Hawaii	319	500
KGW	Portland, Oregon	484	1000
KGY	Lacey, Washington	250	10
KHJ	Los Angeles, Calif.	333	1000
KHQ	Spokane, Wash.	508	1000
KICK	Red Oak, Iowa	211	100
KID	Idaho Falls, Idaho	227	250
KIDO	Boise, Idaho	240	1000
KJBS	San Francisco, Cal(day)	261	100
KJR	Seattle, Wash.	309	5000
KKP	Seattle, Wash.	219	15
KLCN	Blytheville, Ark. (day)	232	50
KLRA	Little Rock, Ark.	216	500
KLS	Oakland, Calif. (day)	208	250
KLX	Oakland, Calif.	341	500
KLZ	Denver, Colo.	535	1000
KMA	Shenandoah, Iowa	322	500
KMBC	Independence, Mo.	316	500
KMED	Medford, Oregon	229	50
KMIC	Inglewood, Calif.	268	500
KMJ	Fresno, Calif.	250	100
KMMJ	Clay Center, Neb. (day)	405	1000
KMO	Tacoma, Wash.	224	500
KMOX	St. Louis, Mo.	275	25000
KMTR	Hollywood, Calif.	526	1000
KNX	Los Angeles, Calif.	286	5000
KOA	Denver, Colo.	361	12500
KOAC	Corvallis, Oregon	535	1000
KOB	State College, N. Mex.	254	10000
KOCW	Chickasha, Okla.	211	100
KOH	Reno, Nevada	219	100
KOIL	Council Bluffs, Iowa	238	1000
KOIN	Portland, Oregon	319	1000
KOL	Seattle, Wash.	236	1000
KOMO	Seattle, Wash.	326	1000
KOOS	Marshfield, Oregon	219	50
KORE	Eugene, Oregon	211	100
KOW	Denver, Colo.	216	500
KOY	Phoenix, Ariz.	229	100
KPCB	Seattle, Wash.	248	100
KPFW	Westminster, Cal.	201	25000
KPJM	Prescott, Arizona	200	100
KPLA	Los Angeles, Calif.	526	1000
KPO	San Francisco, Calif.	441	1000
KPOF	Denver, Colo.	341	500
KPPC	Pasadena, Calif.	250	50
KPQ	Seattle, Wash.	248	100
KPRC	Houston, Texas	326	1000
KPSN	Pasadena, Calif.	316	1000
KQV	Pittsburgh, Pa.	217	500
KQW	San Jose, Calif.	297	500
KRE	Berkeley, Calif.	219	100
KRGV	Harlingen, Texas	238	500
KRLD	Dallas, Texas	288	10000
KRMD	Shreveport, La.	229	50
KRSC	Seattle, Wash. (day)	268	50
KSAC	Manhattan, Kans.	517	500
KSBA	Shreveport, La.	207	1000
KSCJ	Sioux City, Iowa	225	1000
KSD	St. Louis, Mo.	545	500
KSEI	Pocatello, Idaho	333	250
KSL	Salt Lake City, Utah	265	5000
KSMR	Santa Maria, Calif.	250	100
KSO	Clarinda, Iowa	217	1000
KSOO	Sioux Falls, S. D. (day)	270	1000
KSTP	St. Paul, Minn.	205	10000
KTAB	Oakland, Calif.	545	500
KTAP	San Antonio, Texas	211	100
KTAT	Fort Worth, Texas	242	1000
KTBI	Los Angeles, Calif.	231	750
KTBR	Portland, Oregon	231	500
KTHS	Hot Springs, Ark.	375	10000
KTM	Santa Monica, Calif.	428	500
KTNT	Muscatine, Iowa (day)	256	5000
KTSA	San Antonio, Texas	232	1000
KTSL	Cedar Grove, La.	229	50
KTUE	Houston, Texas	211	5
KTW	Seattle, Wash.	236	1000
KUJ	Seattle, Wash.	200	10
KUOA	Fayetteville, Ark.	216	1000
KUOM	Missoula, Mont.	526	500
KUSD	Vermillion, S. D.	337	500
KUT	Austin, Texas	268	500
KVI	Des Moines, Wash.	224	1000
KVL	Seattle, Wash.	219	100
KVOO	Tulsa, Okla.	263	5000
KVOS	Bellingham, Wash.	250	100
KWBS	Portland, Oregon	200	15
KWCR	Cedar Rapids, Iowa	229	100
KWEA	Shreveport, La.	248	100
KWG	Stockton, Calif.	250	100
KWJJ	Portland, Ore. (Ltd.)	283	500
KWK	St. Louis, Mo.	222	1000
KWKC	Kansas City, Mo.	219	100
KWKH	Shreveport, La.	353	20000
KWLC	Decorah, Iowa (day)	236	100
KWSC	Pullman, Wash.	216	500
KWTC	Santa Ana, Calif.	200	100
KWWG	Brownsville, Texas	238	500
KWYO	Laramie, Wyoming	500	500
KXA	Seattle, Wash.	526	500
KXL	Portland, Oregon	240	500
KXO	El Centro, Calif.	250	100
KXRO	Aberdeen, Wash.	211	75
KYA	San Francisco, Calif.	244	1000
KYW and KYWA	See KFKX		
KZM	Oakland, Calif.	219	100
NAA	Arlington, Va.	434	1000
WAAD	Cincinnati, Ohio	211	25
WAAF	Chicago, Ill. (day)	326	500
WAAM	Newark, N. J.	240	1000
WAAT	Jersey City, N.J. (day)	280	300
WAAW	Omaha, Neb. (day)	454	500
WABC	New York City	349	5000
WABF	Kingston, Pa.	208	250
WABI	Bangor, Maine	250	100
WABO	Rochester, N. Y.	208	500
WABY	Philadelphia, Pa.	229	50
WABZ	New Orleans, La.	250	100
WADC	Akron, Ohio	227	1000
WAFD	Detroit, Mich.	200	100
WAGM	Royal Oak, Mich.	229	50
WAIU	Columbus, Ohio (Ltd.)	468	5000
WALK	Willow Grove, Pa.	200	50
WAPI	Birmingham, Ala.	263	5000
WASH	Grand Rapids, Mich.	236	250
WBAA	West Lafayette, Ind.	214	500
WBAK	Harrisburg, Pa. (day)	210	500
WBAL	Baltimore, Md.	283	10000
WBAP	Fort Worth, Texas	375	25000
WBAW	Nashville, Tenn.	201	5000
WBAX	Wilkes-Barre, Pa.	248	100
WBBC	Brooklyn, N. Y. City	214	500
WBBL	Richmond, Va.	219	100
WBBM	Chicago, Ill.	389	25000
WBBR	Rossville, N. Y. City	231	1000
WBBY	Charleston, S. C.	250	75
WBBZ	Ponca City, Okla.	250	100
WBCM	Bay City, Mich.	213	500
WBCN	See WENR		
WBIS	Boston, Mass.	244	500
WBMH	Detroit, Mich.	229	100
WBMS	Fort Lee, N. J.	207	250
WBNY	New York City	222	250
WBOQ	See WABC		
WBOW	Terre Haute, Ind.	229	100
WBRC	Birmingham, Ala.	322	500
WBRE	Wilkes-Barre, Pa.	229	100
WBRL	Tilton, N. H.	210	500
WBSO	Wellesley Hills, Mass. (Time limited)	384	250
WBT	Charlotte, N. C.	278	10000
WBZ	Springfield, Mass.	303	15000
WBZA	Boston, Mass.	303	500
WCAC	Storrs, Conn.	500	250
WCAD	Canton, N. Y. (day)	246	500
WCAE	Pittsburgh, Pa.	246	500
WCAH	Columbus, Ohio	210	250
WCAJ	Lincoln, Neb.	508	500
WCAL	Northfield, Minn.	240	1000
WCAM	Camden, N. J.	234	500
WCAO	Baltimore, Md.	500	250
WCAP	Asbury Park, N. J.	234	500
WCAT	Rapid City, S. D.	250	100
WCAU	Philadelphia, Pa.	256	5000
WCAX	Burlington, Vt.	250	100
WCAZ	Carthage, Ill. (day)	280	100
WCBA	Allentown, Pa.	208	250
WCBD	Zion, Illinois (day)	278	5000
WCBM	Baltimore, Md.	219	100
WCBS	Springfield, Ill.	248	100
WCCO	Minneapolis, Minn.	370	15000
WCDA	New York City	222	250
WCFL	Chicago, Ill. (Ltd.)	309	25000
WCGU	Brooklyn, N. Y. City	214	500
WCKY	Harrison, Ohio	203	5000
WCLB	Brooklyn, N. Y. City	200	100
WCLO	Kenosha, Wis.	250	100
WCLS	Joliet, Ill.	229	100
WCMA	Culver, Ind.	214	500
WCOA	Pensacola, Fla.	268	500
WCOC	Columbus, Miss.	341	500
WCOH	Greenville, N. Y.	248	100
WCRW	Chicago, Ill.	248	100
WCSH	Portland, Maine	319	500
WCSO	Springfield, Ohio	217	500
WCX	See WJR		
WDAE	Tampa, Fla.	484	1000
WDAF	Kansas City, Mo.	492	1000
WDAG	Amarillo, Texas	213	1000
WDAH	El Paso, Texas	229	100
WDAY	Fargo, N. D.	234	1000
WDBJ	Roanoke, Va.	322	250
WDBO	Orlando, Fla.	484	1000
WDEL	Wilmington, Del.	268	250
WDGY	Minneapolis, Minn.	536	500
WDOD	Chattanooga, Tenn.	234	1000
WDRC	New Haven, Conn.	225	500
WDSU	New Orleans, La.	236	1000
WDWF	Cranston, R. I.	248	100
WDZ	Tuscola, Illinois	280	100
WEAF	New York City	454	25000
WEAI	Ithaca, N. Y. (day)	236	1000
WEAN	Providence, R. I. (day)	545	500
WEAO	Columbus, Ohio	545	750
WEAR	See WTAM		
WEBC	Superior, Wis.	234	1000
WEBE	Cambridge, Ohio	248	100
WEBO	Harrisburg, Ill.	248	50
WEBR	Buffalo, N. Y.	229	100
WEBW	Beloit, Wis. (day)	500	250
WEDC	Chicago, Ill.	248	100
WEDH	Erie, Pa.	211	30
WEEI	Boston, Mass.	508	500
WEHS	Evanston, Ill.	229	100
WELK	Philadelphia, Pa.	219	100
WEMC	Berrien Springs, Mich.	508	1000
WENR	Chicago, Ill.	345	25000
WEPS	Gloucester, Mass.	250	100
WEVD	New York City	231	1000
WEW	St. Louis, Mo. (day)	395	1000
WFAA	Dallas, Texas	288	25000
WFAN	Philadelphia, Pa.	492	500
WFBC	Knoxville, Tenn.	250	50
WFBE	Cincinnati, Ohio	250	100
WFBG	Altoona, Pa.	229	100
WFBJ	Collegeville, Minn.	219	100
WFBL	Syracuse, N. Y. (temporarily 201 meters, 1000 watts)	333	750
WFBM	Indianapolis, Ind. (Ltd)	244	1000
WFBR	Baltimore, Md. (temp.)	236	250
WFDF	Flint, Michigan	229	100
WFI	Philadelphia, Pa.	535	500
WFIW	Hopkinsville, Ky.	319	1000
WFJC	Akron, Ohio	207	500
WFKD	Philadelphia, Pa.	229	50
WFLA	See WSUN		
WGAL	Lancaster, Pa.	229	15
WGBB	Freeport, N. Y.	248	100
WGBC	Memphis, Tenn.	210	500
WGBF	Evansville, Ind.	476	500
WGBI	Scranton, Pa.	341	250
WGBS	New York City (Ltd.)	254	500
WGCM	Gulfport, Miss.	248	100
WGCP	Newark, N. J.	240	250
WGES	Chicago, Ill.	220	500
WGH	Newport News, Va.	229	100
WGHP	Mt. Clemens Mich.	242	750
WGL	Fort Wayne, Ind.	219	100
WGMS	See WLB		
WGN	Chicago, Ill.	416	25000
WGR	Buffalo, N. Y.	545	1000
WGST	Atlanta, Ga.	337	250
WGY	Schenectady, N. Y.	380	50000
WHA	Madison, Wis.	526	750
WHAD	Milwaukee, Wis. (day)	268	250
WHAM	Rochester, N. Y.	261	5000
WHAP	New York City	231	1000
WHAS	Louisville, Ky.	366	5000
WHAZ	Troy, N. Y.	231	500
WHB	Kansas City, Mo.	316	500
WHBC	Canton, Ohio	250	10
WHBD	Bellefontaine, Ohio	219	100
WHBF	Rock Island, Ill.	248	100
WHBL	Sheboygan, Wis.	213	500
WHBP	Johnstown, Pa.	229	100
WHBQ	Memphis, Tenn.	219	100
WHBU	Anderson, Indiana	248	100
WHBW	Philadelphia, Pa.	200	100
WHBY	West De Pere, Wis.	250	100
WHDF	Calumet, Mich.	219	100
WHDH	Gloucester, Mass. (day)	361	1000
WHDI	Minneapolis, Minn.	536	500
WHDL	Tupper Lake, N. Y.	211	10
WHEC	See WABO		
WHFC	Chicago, Ill.	229	100
WHIS	Bluefield, W. Va.	211	100
WHK	Cleveland, Ohio	216	2000
WHN	New York City	297	250
WHO	Des Moines, Iowa	300	5000
WHPP	New York City	211	10
WIAS	Ottumwa, Iowa (day)	211	100
WIBA	Madison, Wis.	248	100
WIBG	Elkins Park, Pa. (Sun.)	322	50
WIBM	Jackson, Mich.	219	100
WIBO	Chicago, Ill.	526	5000
WIBR	Steubenville, Ohio	211	50
WIBS	Elizabeth, N. J.	207	250
WIBU	Poynette, Wis.	229	100
WIBW	Topeka, Kans.	231	1000
WIBX	Utica, N. Y.	250	100
WIBZ	Montgomery, Ala.	200	15
WICC	Bridgeport, Conn. (day)	252	500
WIL	St. Louis, Mo.	211	100
WILL	Urbana, Ill.	337	250
WILM	Wilmington, Del.	200	100
WINR	Bay Shore, N. Y.	248	100
WIOD	Miami Beach, Fla.	242	1000
WIP	Philadelphia, Pa.	492	500
WISN	Milwaukee, Wis.	268	250
WJAD	Waco, Texas	242	1000
WJAG	Norfolk, Neb. (day)	283	1000
WJAK	Kokomo, Ind.	229	50
WJAR	Providence, R. I.	337	500
WJAS	Pittsburgh, Pa.	232	1000
WJAX	Jacksonville, Fla.	238	1000
WJAY	Cleveland, Ohio	207	500
WJAZ	Chicago, Ill.	203	5000
WJBC	LaSalle, Ill.	250	100
WJBI	Red Bank, N. J.	248	100
WJBK	Ypsilanti, Mich.	219	50
WJBL	Decatur, Ill.	250	100
WJBO	New Orleans, La.	219	100
WJBT	See WBBM		
WJBU	Lewisburg, Pa.	248	100
WJBW	New Orleans, La.	250	30
WJBY	Gadsden, Ala.	248	50
WJJD	Mooseheart, Ill. (Ltd.)	265	20000
WJKS	Gary, Ind.	220	500
WJR	Detroit, Mich.	400	5000
WJSV	Washington, D. C.	205	10000
WJZ	New York City	395	25000
WKAQ	San Juan, Porto Rico	337	500
WKAR	East Lansing, Mich. (day)	288	500
WKAV	Laconia, N. H.	229	100
WKBB	Joliet, Ill.	229	100
WKBC	Birmingham, Ala.	229	100
WKBE	Webster, Mass.	250	100
WKBF	Indianapolis, Ind.	214	500
WKBH	La Crosse, Wis.	217	1000
WKBI	Chicago, Ill.	229	50
WKBN	Youngstown, Ohio	526	500
WKBO	Jersey City, N. J.	207	250
WKBP	Battle Creek, Mich.	211	50
WKBQ	New York City	222	250
WKBS	Galesburg, Ill.	229	100
WKBV	Brookville, Ind.	200	100
WKBW	Buffalo, N. Y.	204	5000
WKBZ	Ludington, Mich.	200	50
WKEN	Buffalo, N.Y. (Ltd.)	288	1000
WKJC	Lancaster, Pa.	250	100
WKRC	Cincinnati, Ohio	545	500
WKY	Oklahoma City, Okla.	333	1000
WLAC	Nashville, Tenn.	201	5000
WLAP	Louisville, Ky.	250	30
WLB	Minneapolis, Minn.	240	1000
WLBC	Muncie, Ind.	229	50
WLBF	Kansas City, Mo.	211	100
WLBG	Petersburg, Va.	250	100
WLBH	Farmingdale, N. Y.	211	100
WLBL	Stevens Point, Wis. (day)	333	2000
WLBO	Galesburg, Ill.	229	100
WLBV	Mansfield, Ohio	248	100
WLBW	Oil City, Pa.	238	500
WLBX	Long Island City N. Y.	200	100
WLBZ	Bangor, Maine	484	250
WLCI	Ithaca, N. Y.	248	50
WLEX	Medford, Mass.	220	500
WLEY	Lexington, Mass.	211	100
WLIB	See WGN		
WLIT	Philadelphia, Pa.	535	500
WLOE	Chelsea, Mass.	200	100
WLS	Chicago, Ill.	345	5000
WLSI	See WDWF		
WLTH	Brooklyn, N. Y.	214	500
WLW	Cincinnati, Ohio	428	25000
WLWL	New York City	273	5000
WMAC	Cazenovia, N. Y.	526	500
WMAF	So. Dartmouth, Mass.	220	500
WMAK	Buffalo, N. Y.	333	750
WMAL	Washington, D. C.	476	500
WMAN	Columbus, Ohio	248	50
WMAQ	Chicago, Ill.	447	5000
WMAY	St. Louis, Mo.	250	100
WMAZ	Macon, Ga.	250	250
WMBA	Newport, R. I.	200	100
WMBC	Detroit, Mich.	211	100
WMBD	Peoria, Ill.	208	500
WMBF	Miami Beach, Fla.	535	500
WMBG	Richmond, Va.	248	100
WMBH	Joplin, Mo.	211	100

THIS list of stations in the United States operating under licenses issued by the Federal Radio Commission is corrected to March 11, 1929. Powers shown are the night strength, or minimum.

Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
WMBI	Chicago, Ill. (day)	278	5000
WMBJ	Wilkinsburg, Penna.	200	100
WMBL	Lakeland, Fla.	229	100
WMBM	Memphis, Tenn.	200	10
WMBO	Auburn, N. Y.	219	100
WMBQ	Brooklyn, N. Y.	200	100
WMBR	Tampa, Fla.	248	100
WMBS	Harrisburg, Pa.	210	500
WMC	Memphis, Tenn.	384	500
WMCA	New York City	526	500
WMES	Boston, Mass.	200	50
WMMN	Fairmont, W. Va.	337	250
WMPC	Lapeer, Mich.	200	100
WMRJ	Jamaica, N. Y. City	211	10
WMSG	New York City	222	250
WMT	Waterloo, Iowa	250	100
WNAC	See WBIS		
WNAD	Norman, Okla.	297	500
WNAT	Philadelphia, Pa.	229	100
WNAX	Yankton, S. D.	526	1000
WNBF	Binghamton, N. Y.	200	50
WNBH	New Bedford, Mass.	229	100
WNBJ	Knoxville, Tenn.	229	50
WNBO	Washington, Pa.	250	15
WNBQ	Rochester, N. Y.	200	15
WNBR	Memphis, Tenn.	210	500
WNBW	Carbondale, Pa.	250	5
WNBX	Springfield, Vt.	250	10
WNBZ	Saranac Lake, N. Y. (day)	232	50
WNJ	Newark, N. J.	207	250
WNOX	Knoxville, Tenn.	535	1000
WNRC	Greensboro, N. C.	208	500
WNYC	New York City	526	500
WOAI	San Antonio, Texas	252	5000
WOAN	Lawrenceburg, Tenn.	500	500
WOAX	Trenton, N. J.	234	500
WOBT	Union City, Tenn.	229	15
WOBU	Charleston, W. Va.	517	250
WOC	Davenport, Iowa	300	5000
WOCL	Jamestown, N. Y.	248	25
WODA	Paterson, N. J.	240	1000
WOI	Ames, Iowa (day)	535	3500
WOKO	Peekskill, N. Y.	208	500
WOL	Washington, D.C. (day)	229	100
WOMT	Manitowoc, Wis.	248	100
WOOD	Grand Rapids, Mich.	236	500
WOQ	Kansas City, Mo.	492	1000
WOR	Newark, N. J.	422	5000
WORD	Chicago, Ill.	203	5000
WOS	Jefferson City, Mo.	476	500
WOV	New York City (day)	265	1000
WOW	Omaha, Neb.	508	1000
WOWO	Fort Wayne, Ind.	258	10000
WPAP	New York City	297	250
WPAW	Pawtucket, R. I.	248	100
WPCC	Chicago, Ill.	526	500
WPCH	New York City (day)	370	500
WPG	Atlantic City, N. J.	273	5000
WPOR	See WTAR		
WPRC	Harrisburg, Pa.	250	100
WPSC	State College, Pa. (day)	244	500
WPSW	Philadelphia, Pa.	200	50
WPTF	Raleigh, N. C.	441	10000
WQAM	Miami, Florida	242	1000
WQAN	Scranton, Pa.	341	250
WQAO	See WPAP		
WQBC	Utica, Miss.	220	300
WQBZ	Weirton, W. Va.	211	60
WRAF	LaPorte, Ind.	250	100
WRAK	Erie, Pa.	219	50
WRAW	Reading, Pa.	229	100
WRAX	Philadelphia, Pa. (day)	246	250
WRBC	Valparaiso, Ind. (day)	242	500
WRBI	Tifton, Ga.	229	20
WRBJ	Hattiesburg, Miss.	200	10
WRBL	Columbus, Ga.	250	50
WRBQ	Greenville, Miss.	248	100
WRBT	Wilmington, N. C.	219	50
WRBU	Gastonia, N. C.	248	100
WRBW	Columbia, S. C.	229	15
WRC	Washington, D.C.	316	500
WREC	Memphis, Tenn	500	500
WREN	Lawrence, Kansas	246	1000
WRHM	Minneapolis, Minn.	240	1000
WRJN	Racine, Wis.	219	100
WRK	Hamilton, Ohio	229	100
WRNY	New York City	297	250
WRR	Dallas, Texas	234	5000
WRUF	Gainesville, Fla.	204	5000
WRVA	Richmond, Va.	270	5000
WSAI	Cincinnati, Ohio (Ltd.)	375	5000
WSAJ	Grove City, Pa.	229	100
WSAN	Allentown, Pa.	208	250
WSAR	Portsmouth, R. I.	207	250
WSAZ	Huntington, W. Va.	517	250
WSB	Atlanta, Ga.	405	10000
WSBC	Chicago, Ill.	248	100
WSBT	South Bend, Ind.	244	500
WSDA	Brooklyn, N. Y.	214	500
WSEA	Norfolk, Va.	384	500
WSGH	See WSDA		
WSIS	Sarasota, Fla.	297	250
WSIX	Springfield, Tenn.	248	100
WSM	Nashville, Tenn.	461	5000
WSMB	New Orleans, La.	227	500
WSMD	Salisbury, Md.	229	100
WSMK	Dayton, Ohio	526	200
WSOA	Chicago, Ill.	203	5000
WSPD	Toledo, Ohio	224	500
WSRO	Middletown, Ohio	211	100
WSSH	Boston, Mass.	211	250
WSUI	Iowa City, Iowa	517	500
WSUN	St. Petersburg, Fla.	333	1000
WSVS	Buffalo, N. Y.	219	50
WSYR	Syracuse, N. Y.	526	250
WTAD	Quincy, Ill.	208	500
WTAG	Worcester, Mass.	517	250
WTAM	Cleveland, Ohio	280	3500
WTAQ	Washington,. Wis.	225	1000
WTAR	Norfolk, Va.	384	500
WTAW	College Station, Tex.	268	500
WTAX	Streator, Ill.	248	50
WTAZ	Richmond, Va.	248	15
WTBO	Cumberland, Md.	211	50
WTFI	Toccoa Falls, Ga.	207	500
WTHS	Atlanta, Ga.	229	100
WTIC	Hartford, Conn. Permit 283 meters, 50,000 watts.	500	250
WTMJ	Milwaukee, Wis.	484	1000
WWAE	Chicago, Ill.	250	100
WWJ	Detroit, Mich.	326	1000
WWL	New Orleans, La.	353	5000
WWNC	Asheville, N. C.	526	1000
WWRL	Woodside, N. Y.	200	100
WWVA	Wheeling, W. Va.	258	5000

LIST OF CANADIAN BROADCAST CALLS

CFAC	Calgary, Alta.	434	500
CFBO	St. John, N. B.	337	50
CFCA	Toronto, Ont.	357	500
CFCF	Montreal, Que.	291	1650
CFCH	Iroquois Falls, Ont.	500	250
CFCL	See CKCL		
CFCN	Calgary, Alta.	434	1800
CFCO	Chatham, Ont.	248	25
CFCT	Victoria, B. C.	476	500
CFCY	Charlottetown, P. E. I.	312	100
CFJC	Kamloops, B. C.	268	15
CFLC	Prescott, Ontario	297	50
CFNB	Fredericton, N. B.	248	50
CFQC	Saskatoon, Sask.	329	500
CFRB	Toronto, Ont.	312	1000
CFRC	Kingston, Ont.	268	500
CHCA	See CJCJ		
CHCK	Charlottetown, P. E. I.	312	30
CHCS	Hamilton, Ont.	341	10
CHCT	See CKLC		
CHGS	Summerside, P. E. I.	268	25
CHLS	See CKCD		
CHMA	Edmonton, Alta.	517	250
CHML	Mount Hamilton, Ont.	341	50
CHNC	See CKNC		
CHNS	Halifax, N. S.	322	500
CHRC	Quebec, Quebec	500	5
CHWC	Regina, Sask.	312	15
CHWK	Chilliwack, B. C.	248	5
CJBC	(Uses several Toronto stations)..517, 357 or	312	
CJBR	See CKCK		
CJCA	Edmonton, Alta.	517	500
CJCB	Sydney, Nova Scotia	384	50
CJCJ	Calgary, Alta.	434	250
CJGC	London, Ont.	329	500
CJGX	Yorkton, Sask.	476	500
CJHS	Saskatoon, Sask.	329	250
CJOC	Lethbridge, Alta.	268	50
CJOR	Sea Island, B. C.	291	50
CJRM	Moose Jaw, Sask.	500	500
CJRW	Fleming, Sask.	500	500
CJSC	See CKCL		
CKAC	Montreal, Que.	411	1200
CKCD	Vancouver, B. C.	411	50
CKCI	Quebec, Que.	500	23
CKCK	Regina, Sask.	312	500
CKCL	Toronto, Ont.	517	500
CKCO	Ottawa, Ont.	434	100
CKCR	Brantford, Ont.	297	50
CKCV	Quebec, Que.	500	50
CKFC	Vancouver, B. C.	411	50
CKGW	Bowmanville, Ont.	312	5000
CKLC	Red Deer, Alberta	357	1000
CKMC	Cobalt, Ont.	248	15
CKMO	Vancouver, B.C.	411	50
CKNC	Toronto, Ont.	517	500
CKOC	Hamilton, Ont.	341	100
CKOW	See CFCA		
CKPC	Preston, Ont.	248	25
CKPR	Midland, Ont.	268	50
CKSH	St. Hyacinthe, Que.	297	50
CKUA	Edmonton, Alta.	517	500
CKWX	Vancouver, B. C.	411	100
CKX	Brandon, Man.	556	500
CKY	Winnipeg, Man.	384	5000
CNRA	Moncton, N. B.	476	500
CNRC	See CFAC		
CNRE	See CJCA		
CNRM	See CHYC, CKAC, or CFCF		
CNRO	Ottawa, Ont.	434	500
CNRQ	See CKCV		
CNRR	See CKCK		
CNRS	See CFQC		
CNRT	See CFCA		
CNRV	Vancouver, B. C.	291	500
CNRW	See CKY		
VAS	Louisburg, Nova Scotia	434	

LIST OF SHORT-WAVE STATIONS OF THE WORLD

(Some calls may have been altered under new international regulations.)

Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
	AFRICA		
AIN	Casablanca, Morocco	51.00	
8KR	Constantine, Tunis	42.80	
JP	Johannesburg, U. S. Africa	25.00	
7LO	Nairobi, Kenya	33 50	2,000
	AUSTRALIA		
2BL	Sydney	32.50	
2FC	Sydney	28.50	
2ME	Sydney	28.50	
3AR	Melbourne	55.00	
3LO	Melbourne	32.00	
6AG	Perth, West Australia	32.90	
6WF	Perth	104.50	
	AUSTRIA		
OHK2	Vienna	70.00	
EATH	Vienna	37.00	
	Vienna	22.20	
	BELGIUM		
EB4A2	Brussels	42.00	300
	BRITISH GUIANA		
BZL	Georgetown	43.80	200
	CANADA		
CF	Drummondville, Quebec	32.00	
CJRX	Winnipeg, Man.	25.60	2,000
VAS	Louisburg, N. S.	28.00	
	COSTA RICA		
NRH	Heredia	30.30	7½
	DANTZIG		
EK4ZZZ	Dantzig	40.00	
	DENMARK		
D7MK	Copenhagen	32.05	500
D7RL	Copenhagen	42.12 and 84.24	250
	ENGLAND		
5SW	Chelmsford	25.53	15,000
2NM	Caterham	32.50	
GBS	Rugby	24.40	
	FINLAND		
	Helsingfors (Helsinki)	31.50	
	FRANCE		
F8GC	Paris ("Radio LL")	61.00	500
F8AV	Nogent	80.00	500
Radio Vitus	Paris	37.00	1,500
Eiffel Tower	Paris (time signals)	32.50	
YR	Lyons ("Radio Lyon")	40.20	250
	Agen	30.75	
YN	Lyons	58.00	3,000
	Nancy	15.50	500
FW4	Ste. Assise	24.50	
	GERMANY		
AFI	Konigswusterhausen	14.00	
AFL	Hamburg	70.00 and 52.00	
AFT	Konigswusterhausen	14.00	
AFU	Konigswusterhausen	14.00	
AFK	Berlin (Doberitz)	37.56	75.36
HEA	Nauen		11.00
AGC	Berlin		17.20
AGJ	Nauen		56.70
AGK	Nauen		11.00
LA	Langenberg		43.90
POF	Nauen		11.00
POZ	Nauen		18.10
	Stuttgart		41.00

Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
	HOLLAND		
PCJ	Eindhoven	31.4	30,000
PCKK	Kootwijk	16.00	
PCL	Kootwijk	18.00	32,000
PCMM	Ymuiden	46.50	
PCPP	Kootwijk	16.50	
PCRR	Kootwijk	37.00	
PCTT	Kootwijk	21.00	
PCUU	The Hague	37.00	
PHI	Eindhoven	16.88	
	ITALY		
I1AX	Rome	20 00, 40.00	300
IAY	Placenza	20.00, 45.00	50

THIS list of the short-wave broadcast stations throughout the world is not complete, although we have endeavored to list every station of whom we have heard reports; since in many cases reliable information about the programs, wavelength and power of the stations cannot even be obtained from the stations themselves.

	JAPAN		
JFAB	Taipeh, Formosa	39.50	
JHBB	Ibarakiken (Hirasio)	37.50	2,000
JIPP	Tokio	20.00	
JKZB	Tokio	20.00	
JOAK	Tokio...30.00, 60.00, 35.00,	70.00	500
IAA	Iwatsuki	40.00	
	JAVA		
PLE, PLF	Bandoeng	15.74 and 17.00	
	MEXICO		
XC51	Mexico City	44.00	
	MOROCCO		
AIN	Casablanca	51.00	
	NORWAY		
LCHO	Oslo	33.00	
LGN	Bergen	31.25, 30.00	
	U. S. S. R. (RUSSIA)		
RDRL	Leningrad	28.50	
RDW	Moscow	83.00	
RFM	Khabarovsk (Siberia)	70.20	12,000
RFN	Moscow	50.00	
RA19	Tomsk (Siberia)	37.00	
	SPAIN		
EAM	Madrid	30.70	
EAR55	Barcelona		

Radio Call Letters	BROADCAST STA. Location	Wave (Meters)	Power (Watts)
	SWEDEN		
SAS	Karlsborg	52.50	
SAA	Karlskrona	44.40	
	Motala	99 and 41.45	1,000
SAJ	Karlsborg	47.00	
SMHA	Stockholm	41.00	
	SWITZERLAND		
EH9OC	Berne	32.00	
EH9XD	Zurich	85.00 and 32.00	
	UNITED STATES		
KDKA (W8XK)	East Pittsburgh, Pa.	62.50	40,000
	(W8XS, W8XP-portable)	42.75	
		25.40	
KEJK (W6XAN)	Los Angeles, Calif.	105.90	250
KEWE	Bolinas, Calif.	14.10	
KFPY (W7XAB)	Spokane, Washington	105.90	100
KFQU (W6XBH)	Holy City, Calif.	31.00	50
KFQZ (W6XAL)	Hollywood, Calif.	108.20	50
KFVD (W6XBX)	Culver City, Calif.	105.00	50
KFWB (W6XBR)	Los Angeles, Calif.	105.00	50
		40.00	
KFWO (W6XAD)	Avalon, Calif.	53.07	100
KGER (W6XBV)	Long Beach, Calif.	48.86	
KGB	San Diego, Calif.	65.18	
KGDE	Barrett, Minn.	40.00	50
KGO (W6XAX, W6XN)	San Francisco, Calif.	10 to 40	10,000
KHJ (W6XAU)	Los Angeles, Calif.	104.10	50
KJBS (W6XAR)	San Francisco, Calif.	61.00	50
KJR (W7XC, W7XO)	Seattle, Washington	105.20	250
KMOX	St. Louis, Mo.	49.00	15
KMTR	Los Angeles, Calif.	108.20	250
KNRC (W6XAF)	Santa Monica, Calif.	108.20	100
KNX (W6XA)	Los Angeles, Calif.	107.10	100
KOIL (W9XU)	Council Bluffs, Iowa	61.06	500
KWE-KEWE	Bolinas, Calif.	14.10	
KWJJ (W7XAO)	Portland, Oregon	53.54	100
NAA	Arlington, Va.	48.99 and 31.39	
WAAM (W2XBA)	Newark, N. J.	65.18	50
WABC (W2XE)	Richmond Hill, N. Y.	58.50	500
WAJ	Rocky Point, N. Y.	22.48	
WBRL (W1XY)	Tilton, N. H.	109.00	250
WBZ	Springfield, Mass.	70.00	
WCFL	Chicago, Ill.	37.24	
WCGU (W2XBH)	Brooklyn, N. Y.	54.00	150
WCSH (W1XAB)	Portland, Maine	63.79	250
WCX	Pontiac, Michigan	22.00	75
WEAJ	Rocky Point, N. Y.	22.48	
WEAO (W8XJ)	Columbus, Ohio	54.02	25
WGY (W2XAF)	Schenectady, N. Y.	31.48	
(W2XAD)	Schenectady, N. Y.	19.56	
		5.00	
WHK (W8XF)	Cleveland, Ohio	66.04	500
WJR-WCX (W8XAO)	Pontiac, Michigan	32.00	
WIZ	New Brunswick, N. J.	43.45	
WJZ (W3XAL)	New York, N. Y.	49.18 to 13.95	30,000
WLW (W8XAL)	Cincinnati, Ohio	52.02	250
WNAL (W9XAB)	Omaha, Neb.	105.00	50
WNBT	Elgin, Ill. (Time Signals)	35.50	500
WND	Ocean Township, N. J.	46.48	
WOR (W2XAQ)	Kearny, N. J.	65.40	50
WOWO	Fort Wayne, Ind.	22.80	1,000
WRNY (W2XAL)	New York, N. Y.	30.91	500
WSM (4XD)	Nashville, Tenn.	31.43	
WTFF	Mt. Vernon, Va.	56.00	

(Several short waves are used for transatlantic telephony. This is private business, not broadcasting.)

On the Short Waves

TRANSATLANTIC RELAYS RESUMED

What the short-wave fans have been enjoying for a long time, as readers of this department know, was afforded to the radio public recently, when the National Broadcasting Company put the program of 2LO on the air over its network. The signals were carried across the Atlantic on 25.53 meters from 5SW. Unfortunately, however, no advance notification had been given; but it has been promised that this will be repeated. In 1924 an international broadcast was conducted from 2LO, London, and repeated by WJZ, WGY and WRC. However, since static is no respecter of schedules, the broadcast engineers hesitate to announce such an event in advance. Reversing the compliment, English listeners were given the opportunity by the British Broadcasting Co. to hear the inauguration of President Hoover, but here again, after fifteen minutes, the violent atmospheric conditions prevailing on that day caused the rebroadcast to be discontinued—though at the time of its commencement the words came "clear as a bell."

DOWN TO 10 METERS ON "RADIO NEWS" S-W RECEIVER

Editor, RADIO NEWS:

Readers who have altered their 1927 model RADIO NEWS Short-Wave Receivers to embody the UX-222 Shield-Grid Tube (or even those who have not) will be glad to know that they can very easily enter the real "thrill band" of 28-megahertz (28,000 kilocycles) if they will go to a little trouble and spend a very small amount of money.

Now, the 1927 receiver embodied Aero coils, and this receiver as arranged to take a stage of R.F. with UX-222 (see top of page 655, RADIO NEWS for January, 1929—incidentally, what is "366T" there for? I don't think I put it there) embodies these coils; also using General Radio base and forms for the R.F. stage. Consequently, it is a very simple matter to make two inductances as shown in Figs. 2 and 3.

Obtain a strip of ebonite 7 inches long, ¾-inch wide, and 3/16-inch thick and cut it in half. Now, drill holes in one half spaced as in Fig. 1 to accommodate the General Radio contact plugs and, in the other half, drill two holes spaced as in Fig. 3 (this is assuming that the finished coil will have to fit into G.R. base). Next, wind two turns of 18-gauge enamelled best electrolytic copper wire as in Fig. 2, and solder to plugs F and G (corresponding to filament and grid on Aero base); then wind 5 turns of No. 32 S.S.C. for tickler. Keep this together by dabs of suitable cement at intervals round the circumference and the finished coil should look like, and conform to the measurements of, Fig. 2. Fig. 3 is self-explanatory; the wire being also 18-gauge.

This being done, the reader will have the satisfaction of having really low-loss air-spaced inductances and, if his S.W. receiver has been well made and thoughtfully laid out, he can with a reasonable degree of confidence insert these coils and proceed into moderately "unknown depths"; remembering that a movement of 25 degrees on the detector dial will probably cover a variation in wavelength of only one meter!!

Having inserted the coils see if you can make the detector oscillate, if not, increase its plate voltage—failing this expedient alter value of detector grid fixed condenser. Having got the detector oscillating swing the grid tuning dial very slowly (if noisy look to the friction mechanism) and endeavor to pick up the harmonic of either WIK on 21.38 or GBM on 21.5 which will tell you that you are on 10.67 and 10.75 meters respectively. This done you will have the great satisfaction of having joined the Pioneer Army of Amateurs in the 28-megahertz band and, apart from your local "W" transmitters, look out for the following, inter alia, "G" stations: 2GN, 2OD, 2CX, 2KF, 2NH, 5VL, 5BY, 5ML, 5LS, 6LL. 6HP, 6SM and remember that the numbers do *not* signify districts as in the States and are, in reality, meaningless.

E. T. SOMERSET, G-BRS 125,
Inholmes Park, Burgess Hill, Sussex, England.

WHO WAS IT?

Editor, RADIO NEWS:

What station did I have on February 9 on PCJ's wavelength (31.4 meters) Between musical selections, taps were sounded on the bugle and before signing off a series of three high-pitched buzzes were given, at 11:40 p. m., E. S .T. I would be more than glad to pay the postage to anyone who thinks he might know the answer.

RICHARD BOGERT,
1416 *Linden St., Allentown, Pa.*

(*Unfortunately, we have no way of identifying unknown stations. Our readers often write and ask for a list of all short-wave stations, hours, etc. There is no correct official list, and the changes are very frequent. However, we will welcome any report of a* new station *from any listener who gets the call or announcement of the station's location distinctly, with as much information about the wave and hours as possible.*—EDITOR.)

ANOTHER REPORT

Editor, RADIO NEWS:

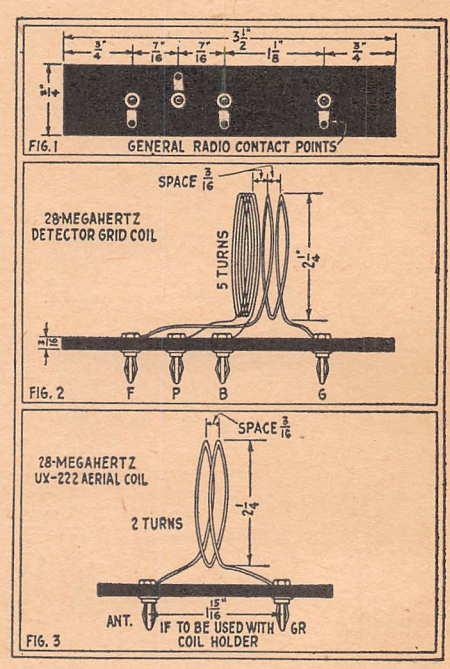
Perhaps it would be of interest to your readers to know that a station PHA located in Germany is broadcasting experimentally on 16.8 meters. I received this, loud-speaker volume, on a three-tube set. A number of short-wave stations have been received here without any special effort to hunt them; which shows that the number of transmitters is increasing.

ROGER W. HODGKINS, W1ASJ,
20 *Bridge St., Bar Harbor, Maine.*

SHORT-WAVE COIL FORMS

Editor, RADIO NEWS:

I have constructed the "Junk-Box" receiver and am getting pretty good results. I can get KDKA on the loud speaker in the daytime—weak though, as might be expected (*Not necessarily*—EDITOR). In constructing the coils, I could not get No. 4



The coils described by Mr. Somerset and used by him in his work on the ten-meter band, the channel of much experiment at present.

all wound on one base, so I devised the plan of combining two tube bases by bolting them together. I wound the grid coil on the top one, the tickler on the bottom one and brought the grid connections through the prongs in the upper base to those on the bottom one. The connections were made first and the two bases were then fastened together and the wires soldered at the prong tips.

JOE MULLER CHRISTIAN,
Eldorado, Texas.

(*The original instructions provided for a cardboard form on a tube base for a coil too long for the base. It will be remembered that a long bolt in the center of a coil will considerably increase its inductance.*—EDITOR.)

ATTENTION TELEVISIONISTS

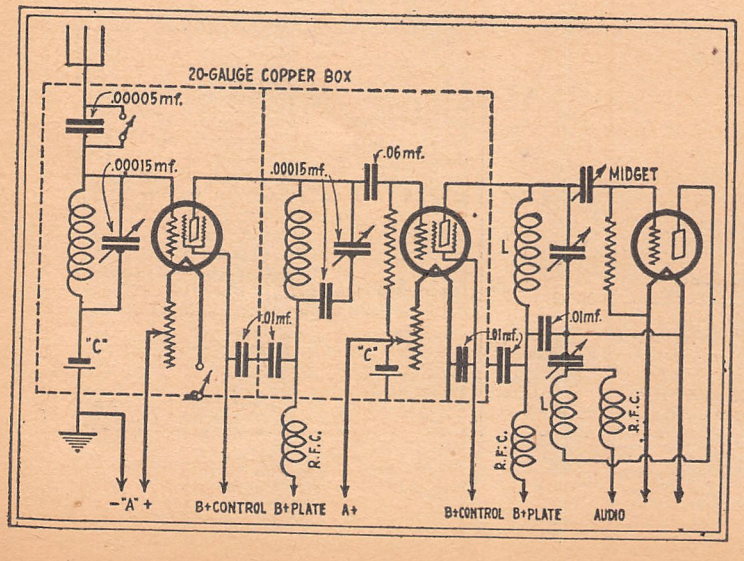
Editor, RADIO NEWS:

We are again on the air with television, between 9 and 11 a. m. (Central time) and continuing daily with the exception of Sundays. Our call letters, W9XAA; Standard scanning, 48 hole, 900 r.p.m.; 146.25 meters, 2050 kilocycles. Programs will consist of movies, stills, and live subjects. Let us know how you receive our television signals.

V. A. SCHOENBERG,
Chief Engineer, WCFL, Chicago, Ill.

DIVIDING THE ETHER

Of the short-wave radio channels available for North American use, a recent division was agreed upon at a conference held in Ottawa, which gives the United States 112 exclusively and 34 shared with Canada and Newfoundland; Canada has 38 exclusive and 48 shared with countries south of the United States, to minimize interference. Newfoundland has 11 channels, shared with the United States; Cuba, 5 exclusive and 15 shared; Mexico, 8 exclusive and 16 shared. Regulations demanding greater accuracy on the part of stations, to avoid getting over the "banks" of their channels, will be enforced by all the subscribing nations.



Most experimenters on the short waves have been content to try not more than one R.F. stage ahead of the regenerative detector. Mr. Somerset, who is an active amateur, and whose reports have appeared frequently in our columns, has introduced two into his receiver. The greatest care is, obviously, necessary in isolating stages at such high frequencies as 28,000 kc., which is around ten meters. This is all code work, and for the amateur, not the S.W. broadcast listener.

ALLOTMENT OF FREQUENCIES

Analyzing the characteristics of the different wavebands, and the suitability of various channels for special purposes, the Radio Commission in its report to Congress states:

"The low-frequency band (which extends from 10 to 550 kilocycles—30,000 *to* 545 *meters*) has presented no problems peculiar to it. Until within the past two years, it had been supposed that the high-frequency band (above 1,500 kilocycles—*below* 200 *meters*) was virtually useless for practical purposes. The erratic behavior of these frequencies, their well-known skip-distance peculiarities, their property of fading, and technical difficulties in the construction of apparatus had all led to the conclusion that, while they furnished an interesting field for experimenters and for amateurs, they could not be the basis of reliable service. It was thought, furthermore, that there was an inexhaustible number of channels in this band of frequencies, at least in comparison with any possible demand; and such licensing as had been done was done without reference to character of service, priority as between classes of service, or any orderly plan. Intensive study and experimentation, however, developed the fact that the high frequencies possess peculiarly valuable properties; their characteristics were found to be in accordance with general laws which might be relied on; and apparatus has been developed capable of transmitting and receiving on these frequencies in a practical way. These frequencies make communication possible at great distances with the use of comparatively small amounts of power; on the other hand, the limitations imposed by the present state of the art with respect to the necessary separation between channels make the number of channels less than had been anticipated."

"The channels in the Continental high-frequency band (1,500 to 6,000 kilocycles—200 *down to* 50 *meters*), except for those just under 6,000 kilocycles, are not considered to have an intercontinental interference range, and their use may be duplicated in different parts of the world. The interference range, however, may affect an entire continent.

"There existed some measure of urgency with regard to the frequencies suitable for long-distance or transoceanic communication (6,000 to 23,000 kilocycles—50 *to* 13 *meters*) in order that these frequencies should not be appropriated by other nations to the disadvantage of the United States, and it was desirable that the allocation be completed within two or three months. A memorandum was presented to the commission, recommending the establishment of a separation of 0.1 per cent of the average frequency of each band, alternate channels only to be used in the immediate future. This separation was described as adequate for all services except television, for which a band of at least 100 kilocycles is required. On the basis of 0.1 per cent. separation, there were a total of 398 channels in mobile bands, of which 189 were already in use; 710 channels in the fixed-service bands, of which 412 were already in use; 39 channels in the broadcast bands (for relay broadcasting) of which 19 were already in use. The commission finally decided upon a proportion of 25 per cent. of the total channels, available to the world and not in use, as that which the United States would be justified in using; but its decision in this respect has not been free from criticism in other countries. The interference area in this part of the frequency spectrum is practically the entire world; and continuous use of a spectrum in one country can not in general be duplicated in another.

"There are 16,296 amateur stations licensed; the international convention authorized each government to assign certain frequency bands to amateur use. The commission has followed the policy of authorizing amateur use of all such bands. The commission feels that the amateur has sufficiently demonstrated his usefulness, both in furthering the progress of the science of radio and in furnishing service in times of emergency, to justify a liberal policy with regard to his operation.

"The likelihood is, that as the art progresses, radio problems will increase rather than decrease. The future of such matters as radiotelevision, picture and facsimile transmission, and relay broadcasting can only be matters for speculation. How soon and to what extent the frequency spectrum above 23,000 kilocycles (*below* 13 *meters*) will be developed is also a matter for guesswork. To what extent future advances will make possible an increasing number of channels and the accommodation of a larger number of stations is unknown."

"JUNK-BOX" LIMITATIONS

Editor, RADIO NEWS:

The "Junk-Box" is very good and satisfying; there is no need of sitting up late to get DX. At 9 a. m. I start in with a 15.1-meter station from Holland, and have often had it too loud for comfort. KGO comes in shortly after. From about 2:30 p. m. the entertainment comes from 5SW; after 7, CJRX comes on for an hour. Of course, KDKA is always available. In my locality it is impossible to bring in foreign stations above 25 meters, because of local interference. PCJ and PCL used to come full speaker strength; but now they are killed by interference. I have made coils down to two turns and get code and commercial stations in good shape.

Here is something I would like to know: Could a "Junk-Box" be made up on the Browning-Drake lines, and could a power tube be used?

I get all my stations on the loud speaker, so that the set can be enjoyed by everybody at home.

C. A. CARDANI,
92 East Cottage St., Boston, Mass.

(The principle of the set named by our correspondent, a tuned R.F. stage of radio-frequency amplification, is used in the "Copperclad Special," as well as in the "New York Times" receiver described in this issue. However, it does not lend itself to junk-box construction; because at these very high frequencies, screen-grid amplification and complete shielding must be used to get results from this stage.—EDITOR.)

CHANGING THE COILS

Editor, RADIO NEWS:

Instead of using the coils specified in the December issue of RADIO NEWS for the short-wave receiver, I made some of my own design, and have so far received an unusual number of American and Canadian stations.

I made three 2-inch coils, two of 7 turns and one of 19 turns, using No. 18 bell wire. One of the 7-turn coils is used as the tickler (fixed) and the others as plug-ins. The wavebands covered are approximately 15 to 50 meters with the small coil and 50 to 100 meters with the larger one. I used an ordinary receiving aerial of about 80 feet and, finding that I was passing up several stations on very low waves, I then used an indoor aerial of ten feet and obtained excellent results.

WINFIELD LEE MARTIN,
126 Fortieth St,. Union City, N. J.

(As a rule, it is not so satisfactory to attempt to cover such wide bands with so few coils. With a short-wave receiver especially, it is desirable to spread out stations as far as possible on the dial.—EDITOR.)

CROSS-CONTINENT WORK

Television images were received in Los Angeles on Feb. 3, as a result of a special test with WGY, Schenectady, accompanied by the voice of the subject, David Wark Griffith, motion-picture director. The image was sent out on 19.56 meters and the voice on 31.48; both, it is said, being received clearly in Los Angeles.

GOOD TELEVISION WORK

Editor, RADIO NEWS:

I am a regular reader of your magazine, which I enjoy; a N. R. I. graduate and a service man; and, as I have time to experiment, I do a lot of it. Here just lately I built a short-wave set using Hammarlund coils. I get all of WGY's short waves, and also DKA. I built a television set, using a Raytheon Kino-Lamp, and a Daven 48-line disc and motor. I receive W3XK three nights a week; but, on account of the signal fading out, I am unable to hold the picture in frame, though it is good and clean-cut. To hold the signal, I have to use the head set in the third stage. On Jan. 23, Jenkins' signals came in so loud that I received the whole picture from beginning to end.

Four stages of resistance coupling are ample to operate the loud speaker. The first four tubes are 201A, the last a 171A in whose plate circuit the Kino-Lamp is inserted, in series with a 300-volt B tap. This 300-volt tap is also connected to the plate of the previous 201A through a 250,000-ohm resistor. The preceding A.F. amplifiers are connected to the 200-volt tap; the first through 250,000 ohms, and the second and third through 100,000. The grid leaks of the first two audio stages are 1 megohm, that of the third a 3:1 transformer secondary, and the last two tubes use ¼-megohm, in addition to a 2,000-ohm variable between the power tube's grid and its center tap. The coupling condensers are all .006-mf.

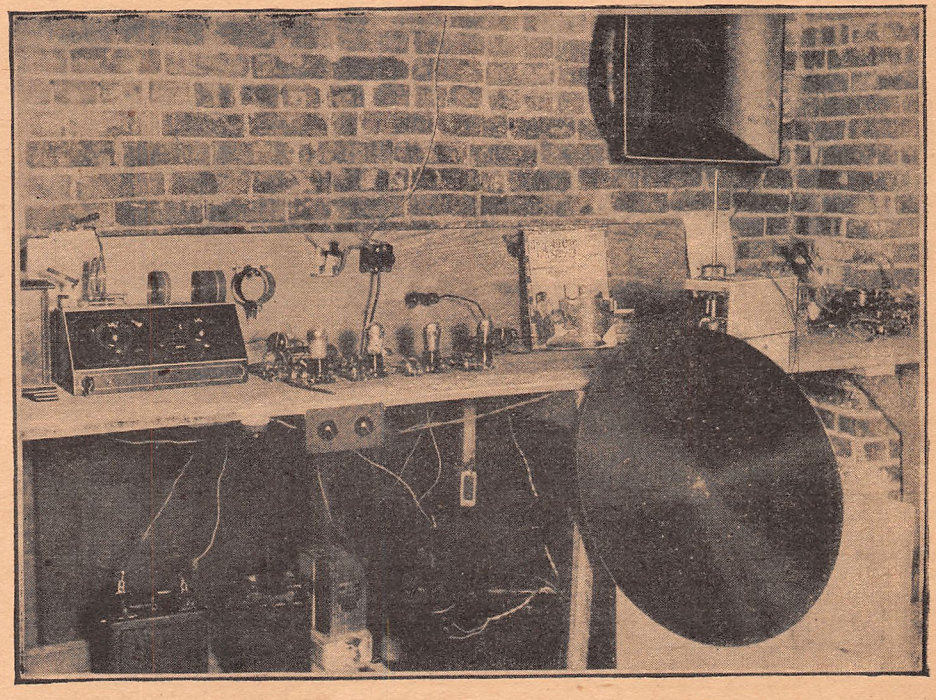
The short-wave set is an ordinary regenerative detector, using a .00016-mf. tuning condenser and a .00025-mf. regeneration condenser. A "B" battery of 45 volts is used; but in addition to an 80-millihenry choke, a 30-henry audio choke is inserted in the plate lead, and a 50,000-ohm resistor. There are two power units with "BH" Raytheon tubes, the last two tubes having their own plate supply independently.

HAROLD W. CHURCHILL,
123 West Stephenson St., Petersburg, Illinois.

(Mr. Churchill accompanied this with a copy of the local newspaper, the Petersburg Observer, *whose editor thus described results:*

"Last Friday evening, the writer sat in the basement of the Warren Churchill home and watched a little girl down in Washington, D. C., bounding a ball on the pavement. And, if you think that the radio was wonderful ten years ago, you should see television. True, the announcer told us beforehand what the picture was going to be, and we used our imagination a little bit, but there she was, just the same. And imagination was no more essential to seeing the picture in television than it was to understand the announcer over the pioneer radio receivers. And the picture is about as plain and flickery as the first movies. And there seems to be another requirement which we forgot to mention. We watched Harold trying to get the motor to synchronize with the speed of

(*Continued on page* 1051)



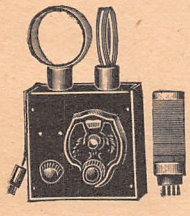
Mr. Churchill's short-wave receiver is in the metal cabinet at the left, with its plug-in coils protruding. The broadcast set beside it is only partly visible. The bench has beneath it both "B" batteries and power units, one of them containing the power stage; while the first few are in the resistance coupler above.

Radio News Laboratories

RADIO manufacturers are invited to send to RADIO NEWS LABORATORIES *samples of their products for test. It does not matter whether or not they advertise in* RADIO NEWS, *the* RADIO NEWS LABORATORIES *being an independent organization, with the improvement of radio apparatus as its aim. If, after being tested, the instruments submitted prove to be built according to modern radio engineering practice, they will each be awarded a certificate of merit; and that apparatus which embodies novel, as well as meritorious features in design and operation, will be described in this department, or in the "What's New in Radio" department, as its news value and general interest for our readers shall deserve. If the apparatus does not pass the Laboratory tests, it will be returned to the manufacturer with suggestions for improvements. No "write-ups" sent by manufacturers are published in these pages, and only apparatus which has been tested in the Laboratories and found of good mechanical and electrical construction is given a certificate. As the service of the* RADIO NEWS LABORATORIES *is free to all manufacturers, whether they are advertisers or not, it is necessary that all goods to be tested be forwarded prepaid, otherwise they cannot be accepted. Apparatus ready for, or already on, the market will be tested for manufacturers free of charge. Apparatus in process of development will be tested at a charge of $2.00 per hour required to do the work. Address all communications and all parcels to* RADIO NEWS LABORATORIES, *230 Fifth Avenue, New York City.* **Readers will be informed on request if any article has been issued a Certificate of Merit.**

SHORT-WAVE ADAPTER

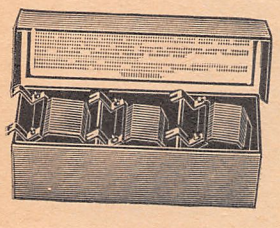
The short-wave adapter illustrated herewith submitted by the R. B. Specialty Company of 318 Sycamore Street, Cincinnati, Ohio, is recommended for use with battery-operated receivers only. The circuit is of the usual regenerative type, employing grid coupling to the antenna. Regeneration is controlled by means of a two-plate compression-type condenser; the grid coil is tuned by a .00015-mf. variable condenser of conventional design. A two-foot cord connects the adapter plug to the converter. Three coils covering the 20-, 40- and 80-meter bands are supplied; the 80-meter coil is wound on a cardboard tube 6 inches in length and 1½ inches in diameter while the 20-and 40-meter coils are of the Hammarlund type. Two UX sockets are mounted on the adapter to receive the detector tube and the coils; the latter are mounted on UX-tube bases. A two-foot lead runs from the fiber cabinet to connect with the aerial. Over-all measurements are 6 x 5 x 4 inches.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2566.

T.R.F. COILS

The set of three radio-frequency transformers shown in the illustration, submitted by the Eastern Coil Company, 56 Christopher Avenue, Brooklyn, New York City, are of the type familiarized by that manufacturer; that is, they are of the "pickle-bottle" variety, octagonal in shape and "air-supported." Both primary and secondary in all three coils are wound with No. 24 double-silk-covered wire; the primary, which is mounted within the secondary, comprises 10 turns of 2-inch diameter, the secondary 70 turns of 2½-inch diameter. The over-all length of each coil is 2⅝ inches; two right-angle brackets on each coil permit of mounting directly to binding posts or terminals of its tuning condenser, which should have a value of .00035-mf. The sheet accompanying the set of coils offers a circuit diagram and a list of parts for a conventional five-tube tuned radio-frequency receiver employing two stages of tuned radio frequency amplification, a tuned detector circuit and two stages of transformer coupled audio frequency amplification.



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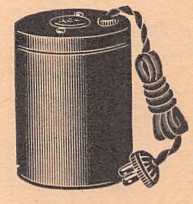
LIGHT-SOCKET AERIAL PLUG

The "Protecto" light-socket aerial plug submitted by the Protecto Manufacturing Company of 2211 Cortelyou Road, Brooklyn, New York City, furnishes on each side an additional outlet from a single house-line receptacle, in addition to an aerial connection brought out through a metal binding post. By the latter, a fixed condenser of .001-mf. capacity is placed in circuit in series with the terminal. The device is furnished with a screw receptacle, and is rated at 250 volts, 10-ampere carrying capacity. It is made of brown composition and measures 1¼ x 1 x 2½ inches in length, without prongs and receptacle.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2575.

INTERFERENCE FILTER

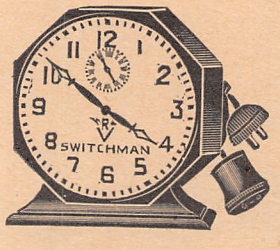
The interference filter submitted by the Trutone Radio Sales Company of 114 Worth Street, New York City, is designed to quiet A.C. and D.C. line-noises; as well as electrical noises emanating from household appliances which operate from the house current. The product is equipped with a six-foot silk cord ending in a plug which fits into the line receptacle; the plug of the cord leading from the receiver is then inserted into the receptacle provided on the can. When the filter is used with a household electrical appliance, it is connected between the latter and the house line. The filter system is contained in a metal cylinder 5 inches high and 3⅞ inches in diameter; its total weight is 4½ pounds. It contains two by-pass condensers wired in series, and tapped at the common lead to supply a connection to the ground.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2576.

ELECTRIC SWITCH CLOCK

The electric switch-clock submitted by the R-V Manufacturing Company of Marshfield, Mass., has a spring-driven movement into which an electric power switch has been incorporated. The switch can be controlled both manually and by the clockwork; so that the clock may be left connected permanently in a circuit, and used for automatic switching only when desired. Its design permits of the automatic turning on of a radio set and if desired it may be set also to turn the receiver off within twelve hours after setting. This clock-switch is designed to operate in connection with A.C. or other socket-power receivers. A long cord, attached to the device, contains a receptacle, into which the receiver is plugged; and the clock circuit is then plugged into the light socket. The electrical rating of the switch is 200 watts on 110 volts. Special types can be had, however, to handle as high as 660 watts. The clock in its entirety measures 4¼ x 4¼ inches, is octagonal in shape and finished in dark brown.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2577.

MAGNETIC LOUD SPEAKERS

The "Model 110 Royal" magnetic loud-speaker submitted by the Amplion Corporation of America, 123 West 21 Street, New York City, and shown herewith, is of the bound-edge-cone type, and operated by a reproducing unit, of the direct-drive type, which is shunted by a tone-filter. The unit is housed in a well-finished walnut cabinet measuring 12 x 10 x 7½ inches. The actual cone is 9 inches in diameter and constructed of an especially treated fabric. A six-foot speaker cord is furnished. This speaker gave excellent reproduction over a major portion of the frequency band, with good volume.

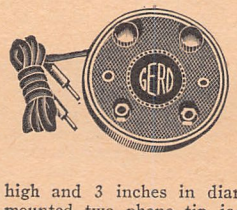
AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2578.

The "Model 118 Prince" magnetic loud-speaker submitted by the same manufacturer and illustrated herewith, is of the bound-edge cone-type driven by a similar reproducing unit, and also housed in a neat walnut cabinet. This measures 12 x 10½ x 7 inches, while the cone itself is 9 inches in diameter and made of the same treated fabric. A six-foot speaker cord is furnished. This speaker was found to have good tone quality with satisfactory sensitivity.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2579.

INTERFERENCE FILTERS

The "Type A" interference filter submitted by the Gerd Electric Company, Kendall Square Building, Cambridge, Massachusetts, and illustrated herewith is designed to reduce annoying and troublesome set, tube or battery noises which would otherwise find their way into the loud speaker. The entire unit is contained in a compact bakelite case, circular in form and measuring ½-inch high and 3 inches in diameter. On the case are mounted two phone tip jacks, into which the cord tips of the loud speaker are to be inserted, and two binding posts, one of which is to be connected to the ground post of the receiver. It is equipped also with a five-foot speaker cord, with tips for insertion in the speaker posts of the receiver.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2580.

The Type "B" interference filter submitted by the same manufacturer is similar in size and appearance to the type "A," except that in place of the phone tip jacks two leads have been substituted; so that they may be connected to the terminals of any interference-producing electrical appliance. Also, the binding posts included in the

(*Continued on page* 1052)

Conducted by C. W. Palmer

IMPORTANT NOTICE TO CORRESPONDENTS

BECAUSE of the large influx of mail, RADIO NEWS now finds it necessary to discontinue answering free of charge, all inquiries to this department. With several hundred letters received daily by this department, the editors have been taxed so severely in answering the present mail that the magazine has begun to suffer. Hereafter, therefore, only letters accompanied by our standard fee (which, by the way, covers only the actual writing of letters and stenographic help) can be considered. Kindly note these simple rules, now in effect:

(1) Correspondents asking answers by mail must enclose 25c for each separate question. Simple radio problems will be answered, but for this nominal charge we cannot make long calculations or thorough investigations.

(2) We cannot give blueprints or layouts for commercial apparatus, or data which the manufacturers have kept secret.

(3) We cannot advise, *even confidentially*, on the respective merits of trade-marked apparatus or "what make to buy."

(4) We cannot send either replies, blueprints, books or magazines C.O.D.

(5) When in doubt, please inquire as to the cost for our services, before remitting.

(6) Be brief. Typewrite or write legibly in ink, on one side of the sheet only. *No attention can be paid to pencilled matter.*

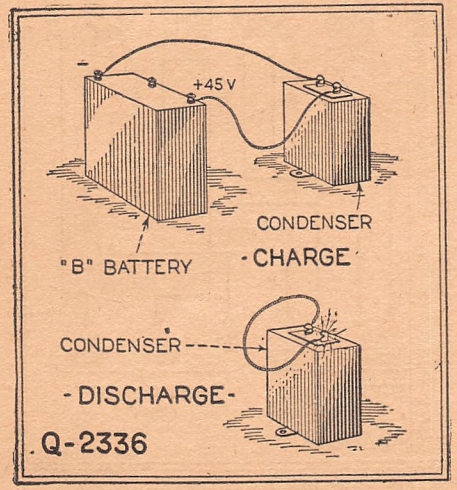
A TEST FOR LARGE CONDENSERS

(2336) Mr. I. V. Dinmore, Windsor, Ontario (Canada), writes:

(Q.) "I am using a 'B' power unit of the Raytheon type with a step-up transformer, rectifier, and filter circuit. The filter circuit contains several condensers and, some time ago, one of these condensers broke down. At that time, I replaced all the condensers with new ones. I am sure, however, that all these condensers are not injured and I would like to use some of them as by-pass condensers in my set. How can I tell which are good and which are not?"

(A.) There are several ways in which a filter condenser may be tested, but probably the simplest is the discharge test. The only apparatus necessary for testing condensers in this way is a "B" battery and two pieces of wire. The battery is connected to the condenser for a minute, to charge it, and then one of the wires is connected from one side of the condenser to the other side (after the battery has been disconnected of course) in order to discharge the condenser. If the latter is in good condition, a spark will jump from it to the wire when that is brought close to the condenser terminal. If the condenser has been previously internally short-circuited, a spark will be seen when the battery is connected to the condenser; in this case, *the battery should be disconnected instantly,* so that it will not be injured. If no spark is obtained when the condenser terminals are shorted, connect the condenser again and repeat the experiment, to be sure that no spark can be obtained. If, at the second attempt, no spark is obtained, it may be assumed that the condenser is defective. If a heavy spark is obtained when the battery is first connected, as mentioned above, the condenser is also defective. The method of connecting the condenser to the battery and discharging it is shown in Fig. Q-2336.

Small condensers, of less than ¼-mf. capacity or thereabouts, cannot be checked satisfactorily in this way; because of the comparatively small amount of current which can be stored in the condenser. The best way to check small condensers, without instruments for measuring the capacity, is to connect a pair of headphones and a "C" battery in series and try this unit across the condenser. In very small condensers, no click will be heard when the contact is made. If a click is heard, of about the same intensity as the click produced by touching the two wires from the phones and battery together, the condenser may be assumed to be defective.



A condenser which will spark when connected is shorted inside; one which will not spark when disconnected is open-circuited within.

A DYNAMIC SPEAKER WITH "B" UNIT

(2337) Mr. Arthur M. Russell, El Paso, Texas, writes:

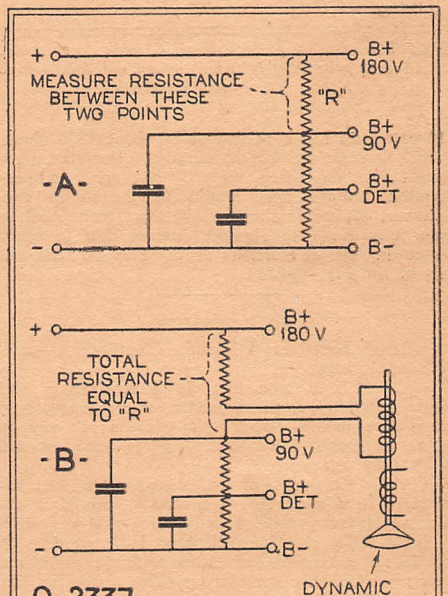
(Q.) "Having purchased a dynamic speaker to operate from a 'B' power unit, I am at a loss to know how to connect it. No instructions were given with the speaker and my power unit is not arranged to be used with a speaker of this type. The field winding of the speaker is designed to operate on 80 to 90 volts at about 80 milliamperes. The 'B' power unit supplies 180 volts at a current of 125 milliamperes, and it has two other output taps for the detector and amplifier. The amplifier supplies 90 volts and the detector 45 volts.

"I believe that the field winding can be actuated from my power unit, but I do not know how to connect it. Will you show me how?"

(A.) The field winding of your speaker can be connected to the "B" power unit, if it is used to replace one of the resistors in the voltage-divider. The most suitable point is between the maximum "B+" terminal and the amplifier tap. In order to insert the winding properly, the resistance between the two points must be known or a variable resistor substituted in place of the regular resistor. The correct connections are shown in Fig. Q-2237. The actual resistance value between the ends of the resistor in question must be the same as the original value, or somewhat less, in order to maintain the taps at the rated values.

Because of the large increase in the current drawn from the unit, it may be advisable to readjust all the resistance values in the voltage divider; and for this purpose, a wire-wound resistor with variable output taps is the most convenient. A power unit supplying more than 80 milliamperes must be used, since there would not otherwise be sufficient current for the tubes in the set. Many of the common "B" power units using full-wave rectifier tubes are designed to supply about 125 milliamperes, and this is sufficient for most receivers.

If, as usual, the dynamic unit requires more current than the tubes of the set, this may be compensated by reducing the two lower-tap resistors; the voltages must be very carefully checked with a high-resistance voltmeter.



A speaker's field windings may replace one resistor in a power unit, if the latter will supply sufficient current for its operation.

PROTECTING RADIO SETS

(2338) Mr. A. F. Jenson, Fairmont, W. Va., writes:

(Q.) "In testing radio sets, a short-circuit sometimes occurs—which is disastrous to the tubes. An accident like this happened to me some time ago; as a result, I had to buy six new tubes and this is an expensive mistake to make very often. I wonder if you have any information on hand which will help me to prevent another such accident. I have seen such devices in magazines at different times, but I cannot locate them."

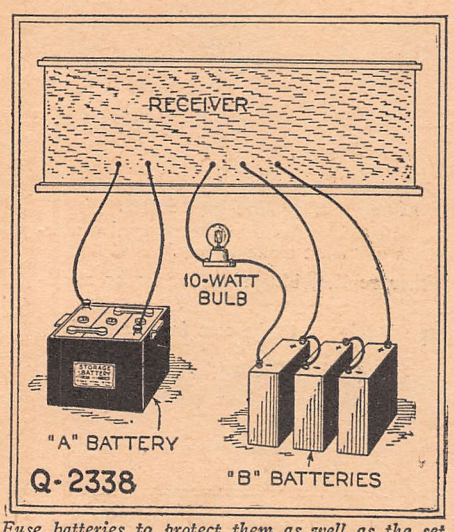
(A.) There are several ways in which a set can be protected from troubles of this nature. Several manufacturers have placed on the market, automatically-operated relays, to open the "B" circuit if a short occurs. These relays are connected in the "B" leads and are always arranged in such a way that they will open the circuit, if sufficient current is passed through them.

There are also several other ways of protecting a set without the use of relays; one of these is to connect resistors of the correct value in each of the "B" leads. The faults of this method are a reduction of the voltages which are impressed on the tubes and, also, the necessity for changing

the resistance value if a different set is operated from the batteries or power supply.

An old 199-type tube connected in the lead from the negative "B" terminal will act as a very good fuse; the filament must be good, in order to complete the "B" circuit. If the "B" voltage is shorted across the filaments of the tubes, the 199 will blow out before the other tubes are injured.

If an old 199 tube is not available, a somewhat similar system can be made by connecting a 10-watt 110-volt bulb in the same position. The



Fuse batteries to protect them as well as the set. A 10-watt tube may be used, or an old tube which lights, but is not serviceable.

10-watt bulb has a resistance of about 1200 ohms, which is sufficient for the purpose. However, in a small set, depending on "B" batteries, a perceptible voltage drop would be caused in this manner. It would therefore be more economical to use fuses made to regulate current flow in small amounts. The connections of the bulb or fuse are shown in Fig. Q-2338.

COIL DESIGN

(2339) Mr. A. Wickson, Toronto, Ontario (Canada), asks:

(Q.1) "Is it true that, in a receiver of the regenerative type, the regeneration overcomes any resistance in the circuit? If this is so, why is there so much talk about 'low-loss' coils wound with very heavy wire?"

(Q.2) "If regeneration compensates for resistance in a receiver (three-circuit), would it affect the primary coil as well as the grid circuit?"

(Q.3) "In a radio coil, how is it possible to obtain the maximum inductance with the minimum self-capacity; only considering three things in the coil, the diameter, the length and the spacing of the turns?"

(A.1) Regeneration in a tube is an action by which energy is "fed back" *from the plate circuit to the grid circuit* of the same tube. In this way, the energy in the plate circuit is added to that in the grid circuit. The strength of the output of the tube is dependent on the strength of the incoming signal, and an increase in the signal will be followed by an increase in the output. The signal current impressed on the tube may thus be increased by coupling the plate circuit inductively to the grid circuit by the use of a feed-back coil, or in any of several other methods.

If the grid circuit of the tube is in *resonance* with the incoming signal (as in a tuned detector or radio-frequency amplifier) the *inductive reactance* and the *capacity reactance* neutralize each other, and the only opposition to the full flow of feed-back current which remains is the small resistance of the wire. If it were possible to remove entirely this resistance, a signal impressed on the tube would continue to act on the circuit forever; since there is no other opposition to the flow of current.

It is apparent that a similar result can be obtained by continually adding a small amount of current in the grid circuit; so that the supply of extra current will compensate for that lost in overcoming the resistance. This is what is done in a regenerative circuit. The effect is sometimes described as that of "negative resistance."

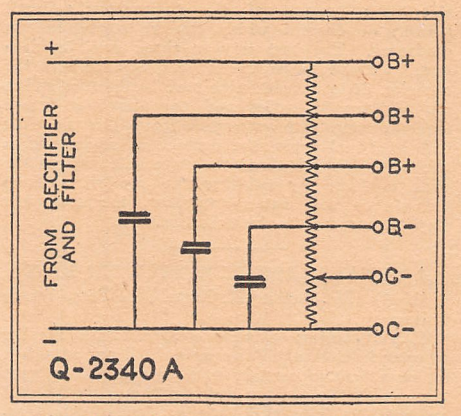
The reason why "low-loss apparatus" has been advocated is because of the undesirability of permitting regeneration in most circuits. The ordinary regenerative set, in which the detector is coupled directly to the aerial, causes a considerable amount of radiation and interference in the neighborhood. Also, a very weak signal requires an excessive amount of additional current in order to build up a loud signal and this causes *distortion*, because of the ratio of the incoming signal to the fed-back current. The difficulties are overcome to some extent by using one or more stages of radio-frequency amplification ahead of the detector; but, even in this case, the aerial may still cause considerable loss of signal strength unless the apparatus is very well designed.

This is the reason for "low-loss," which means low radio-frequency resistance in wiring and coils, low self-capacity in inductors, low dielectric losses in condensers, is, in short, separation of the properties of conductivity, inductance, capacity and resistance into components as "electrically pure" as possible.

(A.2) The effect of the tickler coil on the *primary* coil of the three-circuit coupler is entirely different from its effect on the secondary. The effect, in each case, depends on the relative positions of the coils, as well as on the *phases* of the currents in these two coils; and a number of different effects can be realized under varying conditions.

In general, the tickler will have very little effect on the primary coil, because of the wide separation between them; and the slight effect is usually one of suppression of current rather than a decrease in the resistance due to the feed-back. The explanation for this action is too complicated and varied to give in this place.

(A.3) In designing coils for radio-frequency circuits, it is desirable to keep the resistance and the capacity as low as possible, and to obtain the greatest possible amount of inductance for a given size of coil. The turns of wire on the coil produce inductance, but they also introduce both resistance and capacity; and it is necessary to design the coils very carefully in order to keep these two factors low. The insulation of the wire and the



Output voltage of a power unit may be divided in any ratio by resistors; remembering that the plate circuits are in shunt across them.

form on which the coil is wound produce some of the resistance and most of the capacity; and the resistance of the wire itself, of course, is unavoidable.

There is a potential difference or voltage between the ends of the coil and the wires connecting it to the other apparatus in the receiver. There are also potential differences or voltages between the adjacent turns in the coil and, because of these potentials, each two adjacent turns of wire form the plates of a small condenser, with the insulation and the coil form acting as the "dielectric." It is the combination of all of these small capacities which constitutes the "distributed capacity" of the coil.

There are several undesirable effects resulting from this distributed capacity which must therefore be kept small. In the first place, the capacity of these small condensers tends to by-pass some of the current around the coil and, of course, this lowers the signal voltage across the ends of the coil. The lowest wavelength to which a circuit can be tuned is determined by the minimum values of its capacity and inductance; if either is increased, the minimum wavelength is also increased. The effect of the distributed capacity is to shorten the effective waveband and, on very high frequencies, the value of the distributed capacity may be more important than that of the inductance.

The distributed capacity of a coil is dependent on several factors of the mechanical construction and, by carefully considering them, a coil may be made which will have the greatest number of advantages and the least number of disadvantages. A coil wound on a long tube, of which the diameter is very small and the length comparatively great, has less distributed capacity than one formed on a short tube of large diameter; because of the greater distance between the ends of the windings in the former. (The greater the distance, the lower the capacity between two wires.) Also, the voltage drop between the ends of each turn will be lower because of the shorter length of wire needed for the turn.

The insulation around the wire also helps determine the capacity; since some materials have greater dielectric constants than others, and consequently give less capacity for a given spacing of the metallic wires. Air has the lowest constant; of the materials commonly used cotton is the most effective, then silk, and last comes enamel. A coil wound with bare wire with a minimum of material in the support, and consequently a dielectric almost entirely air, has the lowest possible capacity. Of the materials used for coil forms, paper, cardboard, and wood have the lowest dielectric constants; with hard rubber next. Bakelite, glass and other materials have higher values, although as insulators and supports they have compensating advantages, especially because of their resistance to moisture.

There is less distributed capacity in coils wound with wire of the higher gauges, than in those utilizing larger sizes; but the resistance is higher in small wires. A nominal value can be found (depending on the frequency) which will give the best average value. "Space winding" causes a reduction in the capacity of a coil since it reduces the capacity between all turns. This advantage is overcome to some extent by the greater number of turns required, but not entirely; since the air insulation also causes a reduction and the change is not directly proportional.

However, now that we have found a long, space-wound coil of small wire and small diameter to have least self-capacity, we are confronted also with the mechanical problems of placement, shielding, etc., in which compactness is a decided advantage. For this reason, theoretical considerations as to the most effective coil are outweighed; as a rule, by others which are of more practical importance in set design. Plain solenoid coils of any convenient size will give satisfactory results when used with proper condensers, suitably placed and spaced with regard to other components.

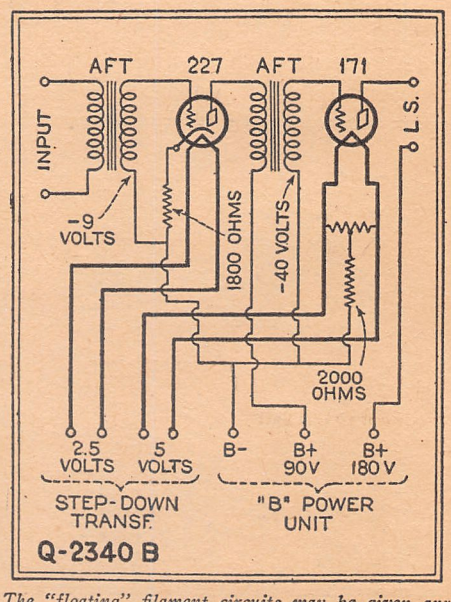
GRID-BIAS RESISTORS

(2340) Mr. R. Williams, Schenectady, N. Y., writes:

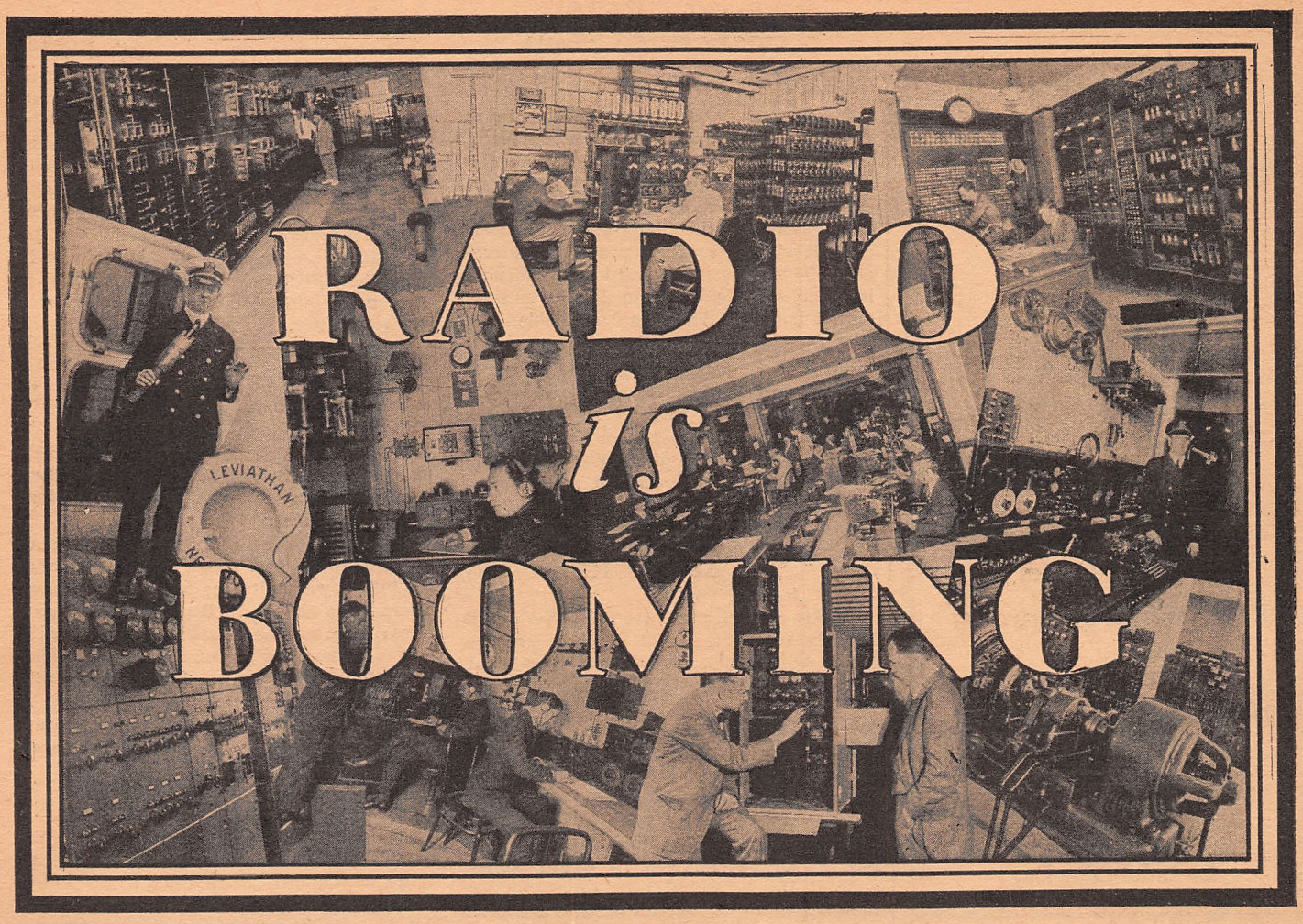
(Q.) "I would like to know just how the biasing voltage is obtained in the grid circuits of tubes, in sets using "ABC" power units; I have been told that the current flows from the plate to the filament, and also from the filament to plate. I just can't understand how a voltage of 40 may be impressed on the grid of one tube and 9 volts on the grid of another tube, in the same set, and having a common ground."

(A.) The direction of the flow of a current is conventionally expressed as from positive to negative, in accordance with the conclusions of experimenters with the first batteries. This is the

(*Continued on page* 1053)



The "floating" filament circuits may be given any desired D.C. voltage in the "B" circuit, determined by the ratio of the tube's plate resistance to that of its grid-bias resistor.



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The Service Man

(*Continued from page* 1019)

it is necessary to place some device between the speaker and the set; in order to prevent the speaker from being injured. A few speakers (including almost all of the dynamic speakers) are equipped with a filter or transformer for this purpose; but in most cases it will be necessary to add one externally. This does not present any difficulty, however, since a large number of suitable output coupling devices are available.

If a larger tube than the 112A or 120 is desired, it is merely necessary to connect proper power-supply voltages to the plate and grid circuits, through the two wires mentioned above. If a 171- or 210-type tube is used, however, the filter must be capable of carrying the extra current required for these tubes.

The Radiola IIIA

Editor, RADIO NEWS:

In this district, there are a number of old Radiola receivers. Most of these are the No. 3 and 3A sets, and I have found that it is impossible to obtain the diagram from the manufacturer. When these sets are injured or fail for any reason, it is very difficult to repair them, because of the lack of a diagram. At this time, I have a Radiola 3A for repairs and my customer wants me also to add some piece of apparatus to improve the tuning and the ability to pick up distant stations. I would appreciate it if you would procure a copy of the diagram of this set for me and also help me to improve the set.

MARTIN'S RADIO SHOP,
Galveston, Texas.

We are printing a diagram of the Radiola 3A receiver herewith, (Fig. 4), since we are sure that it will be of interest to a large number of service men who have to repair these sets. The Radiola 3 receiver is the same as the 3A, except for the last two tubes making up a push-pull amplifier; which is lacking in the number 3 receiver. At the left of the dotted line, you will find indicated an additional tube connected as a radio-frequency amplifier. The use of this tube will improve the selectivity of the set and will also improve the sensitivity to some extent.

The added radio-frequency amplifier consists of a tuning coil, a variable condenser, a radio-frequency choke coil, a tube socket, a filament resistor and the necessary wire connecting the amplifier to the set. The condenser should have a capacity of about .0005-mf. The coil may be made for the purpose or purchased; a suitable one may be made with 50 turns of No. 22 D.C.C. wire at one end of a tube form (3 inches in diameter) for the grid coil and 10 turns of the same wire for the primary or aerial coil. A space of about ¼-inch should be left between the two coils. The radio-frequency choke should have an inductance of at least 60 millihenries.

When building the extra amplifier, it may be advisable to use shielding; although this is not always necessary. It will be seen that the radio-frequency amplifier is connected directly to the grid wiring of the detector tube. This is done because of the tuning system in the set. The fixed condenser in this lead prevents a short-circuit of the plate supply.

The constants of the parts used in the receiver are not all obtainable; but the wiring diagram itself will be of assistance in repairing these sets. The wiring shown leading to the ground is actually connected to the metal panel of the receiver. The values of the fixed condensers are indicated; these condensers are a source of frequent trouble and it will be advisable to test them first before making any other changes in the set. It will be noticed that the "link" is connected here to terminal No. 4; this is done to complete the circuit from the tuning variometer.

Adding a Power Tube to an Old-Style Set

Editor, RADIO NEWS:

My Model 20 Atwater Kent receiver has lost its sensitivity and selectivity. In other words, I am unable to bring in anything but the local stations.

The accessories (*viz.,* the aerial and ground connections, tubes, wet battery and the "B" power unit) are in good condition. There is no change in the power-line locations; there are no new buildings within a half mile from my house, etc. The trouble seems to be inside of the set and not outside (there are no loose connections, however).

Will you please explain the reason for this loss of sensitivity and selectivity, and also suggest possible remedies?

J. J. FELDSTEEN,
Cleveland, Ohio.

The loss of volume or loss of sensitivity in a radio set is usually caused by the tubes. When used as a R.F. amplifier, a tube must be in good condition, or weak signals will not be amplified properly and, of course, this will be noticed as a loss in the sensitivity of the set. Unless one has a portable set tester it is advisable to try new or tested tubes in the sockets of the R.F. amplifier before making any changes in the set or other parts; this might overcome all of the trouble.

The use of too high a plate voltage on the R.F. tubes will also result in a loss of sensitivity, and the use of a poor grid leak or one of the wrong resistance will often entirely change the operation of the set. An aerial may appear to be in good condition and still be rather inefficient. After it has been used for some time, the insulators become coated with carbon, and the wire is corroded. This causes a very noticeable decrease in the signal strength and the sensitivity.

The ground connection is also susceptible and should be checked. A ground clamp becomes corroded or loosens in time, and the connection between the clamp and the ground wire to the set does not make a good contact; with the result that the ground may sometimes be actually disconnected without any apparent effect on the operation.

Loss of selectivity in a set is usually caused by poor connections in the wiring of the R.F. amplifier or the detector; or to the introduction of resistance or losses in the tuning circuits, due perhaps to moisture affecting the insulation of the coils and wiring.

The best method for locating the trouble is to try new tubes in the R.F. and detector sockets; try changing the plate voltage on the R.F. tubes; change the grid leak and try a number of different values, and also try lowering the plate voltage on the detector.

In the matter of the aerial, it is best to replace the wire and insulators with new ones if the aerial has been up for any length of

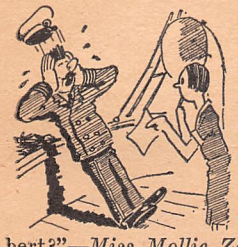
time; especially if there is much dust or smoke in the air (as when the set is located near a factory or railroad line). The lead-in wire and wall insulators should also be replaced; since they might introduce as much loss as a leaky insulator in the aerial proper.

The ground connection, wire and clamp should be changed or a new one tried. The use of a good ground has much to do with the sensitivity of the receiver and, by trying a number of times, one may be found which has a comparatively low resistance. If the set is located in a place where dampness might affect it, it is a good plan to place it in a warm dry place for a time, in order to dry out the insulation, etc. The set should also be dusted out occasionally to remove the dust which collects in it; a pipe cleaner, or a piece of cotton-insulated wire, run between the plates of the variable condensers, will remove the dust from this critical position.

(*The above is a typical analysis of a set in bad order, as it is conducted without a high-priced test kit. Such an instrument permits it to be gone over systematically in a few minutes; and is indispensable for a large servicing business.*

If you have to get along, at present, without one, how do you go over a set to find out what ails it, in the quickest time? Write and tell us about your short cuts and home-made testers.—EDITOR.)

REFERRED TO THE WEATHER BUREAU



SWEET YOUNG THING: "Oh, captain, I've heard that radio affects the weather; but do you think it would storm if I sent a teeny two- or three-word message to Herbert?"—*Miss Mollie Zacharias.*

(See page 623 of RADIO NEWS for January, 1929.—EDITOR.)

A BARGAIN HUNTER

DEALER (*to himself*): "The only way to move this battery set is to mark it down till they've got to buy." (*Letters a placard, "Who will take this high-grade receiver away for $20?" and displays it in the window with set.*)

CUSTOMER (*entering*): "Is that a bonafide offer?"

DEALER: "Yes, sir."

CUSTOMER: "Well, I'm sure there's a catch somewhere, but I'll take a chance on it. Gimme the twenty."—*Edward Piranian.*

PREVENTING A SHOCK

FIRST RADIO FAN: "That radio speaker should be censored!"

SECOND RADIO FAN: "Well, they might put an output filter on him."

—*Wm. G. Mortimer.*

AND HOW!

TEACHER: "Do you like the bedtime stories best, Joey?"

LITTLE JOE: "Sure! Especially those from the Stepin Cabaret."

—*Herbert Seligson.*

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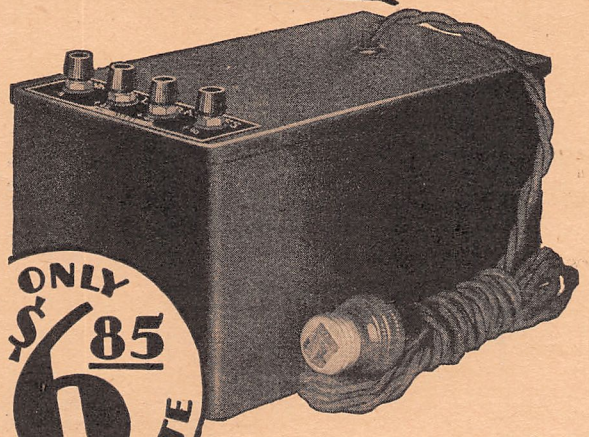

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Am using your Eliminator on a Neutrodyne Super 6-tube and find it just as advertised and perfectly satisfactory. G. Prefontaine, Montreal, Que.

Have used your Eliminator on my Sparton radio for many months. I like it very much and completely satisfied with it. Harry H. Ward, South Bend, Ind.

Have had very good success with the Eliminator purchased some two years ago and like it very much. Harvey E. Grose, Wilton Jct., Iowa.

Have had your Eliminator for two years and consider it the best bargain in Eliminators on the market. Edward Ellison, Anderson, Ind.

I have had wonderful results since using your Eliminator on my 3-tube Harkness "Counterflex." I am able to get on the loud speaker with good volume such stations as Hollywood, Pittsburgh, Shreveport and dozens of others. G. S. Bagot, Edmonton, Alta.

Your Eliminator is living up to everything you claim in your advertisement. To tell the truth I didn't expect it to work near as well as it does, being as it costs so little. William J. Elliott, New City, N. Y.

I am receiving better results with your Eliminator than I ever received with THREE 45-volt "B" batteries. It is working fine on my Atwater Kent model 35. Carl Sporow, Newberry, Pa.

I am more than pleased with your Eliminator. I have heard some real expensive ones that are not any better than mine. Mrs. Cleon Kilpatrick, Bethlehem, Pa.

Have used your Eliminator for over a year and it sure works fine. Geo. E. Steiger, Toledo, Ohio.

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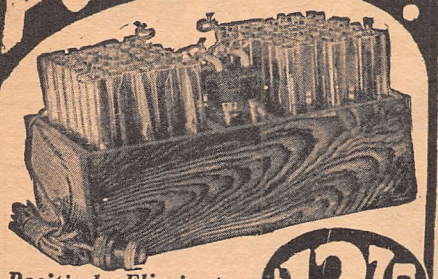

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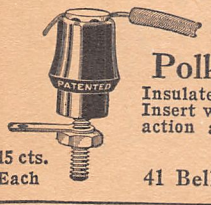

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ELECTRAD

The Radio Beginner---A "Hartley" R.F. Receiver

(Continued from page 1008)

wire is closely paralleled. But keep grid and plate leads, particularly grid leads, in the clear.

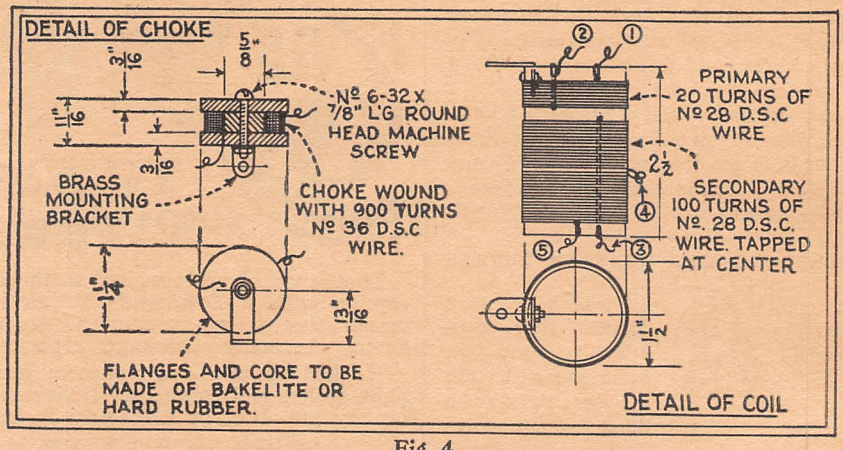
If a 200A detector tube is used, the connection from the center tap of the secondary (contact No. 4) is brought straight to the "F—" terminal of socket V2, instead of the "F+," and also is *not* connected to the "A+" lead running to other sockets as shown. This "A+" lead, however, is connected to the "F+" socket lead. The effect is to bring all the grid and plate returns together to "A—" as in Fig. 1.

If an A.F. transformer is used in the first audio stage, instead of a resistance coupler, the usual connections are made to it from the plate of V2, the "B+45," the grid of V3 and the "A—" lead, as indicated by the respective markings on the transformer.

diagrams; and it will help to avoid error if each line is checked off with a heavy colored pencil, so that the constructor may see what has been already gone over.

TESTING THE CIRCUITS

The filament rheostat can be turned completely "off"; in this position it serves the purpose of a switch. In operation it is both filament regulator and volume control for the set; and has been purposely selected with a resistance much higher than is necessary to reduce the tube voltage to ordinary operating temperature. It should never, in practice, be turned fully "on"; as some of its resistance should be always in the circuit. (It is not probable that the constructor will wish to use 199-type tubes with a 6-volt battery; but if he does so, at least 10 ohms of the rheostat's resistance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PRIMARY 20 TURNS OF Nº 28 D.S.C WIRE
2 1/2"
SECONDARY 100 TURNS OF Nº. 28 D.S.C. WIRE. TAPPED AT CENTER
1 1/2"
DETAIL OF COIL

Fig. 4

The details for making the choke RFC and coil L are shown here. The dimensions of the latter differ somewhat from those employed in ordinary tuned R.F. coils, because of the circuit used.

If a power tube is to be used in socket V4, a "C—" post should be inserted in the binding-post strip at the left, or on the baseboard, and a "C" battery connected into the grid circuit of the power tube, as explained earlier in the article. A 171A tube with 180 volts on the plate requires 40½ volts grid bias, a 112A or a 201A with 135 volts on the plate 9 volts of grid bias. If the set is used with dry-cell tubes, a 120 tube using 135 volts "B" should have 22½ of "C." Even a 201A or a 199 at 90 volts is supposed to have a 4½-volt "C" bias. Such a battery might be included in the cabinet and wired in circuit without the aid of an extra binding post, but this refinement is usually omitted; even though it is supposed to save the "B" batteries and improve reproduction.

After completing the wiring, and being sure that each joint makes a good electrical connection and is properly and strongly soldered, the builder must check it. Each lead should be carefully followed with the aid of both the schematic and the pictorial

should always be in series with the battery lead.)

Attach the red or positive terminal of the "A" battery to the "A+" binding post; turn the rheostat fully "on" and, with the insulation of the "A—" wire in your hand lightly brush the metal contact of the "ground" binding post. If there is a spark, Beware! There is a short-circuit somewhere in the filament wiring which will destroy the battery if it is connected to the set before this is corrected. Test at the "A—" binding post with rheostat "on" and "off." If everything is all right, proceed.

Put a tube—preferably an old one, but

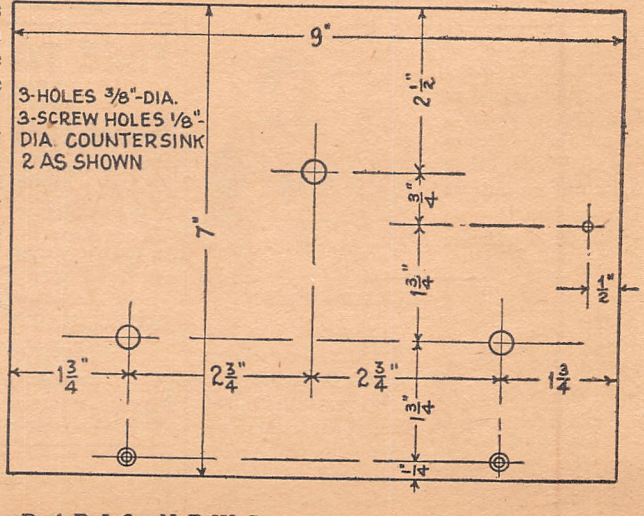

Fig. 3

At the right, drilling details for the panel of the "Hartley" R.F. set. The constructor can easily lay these off without requiring a template.

one which will light—into a socket and connect the "A" battery to its proper binding posts. Turn the rheostat slowly on until the tube lights, and see that it is under control. Try it in each socket successively, until you have found that it lights in each. If everything is all right, the filament circuit is good. Now test the plate circuits.

With the "A" battery connected to "A—" brush first the "B+45", then the "B+Max" and the "B+Power" (if a power tube is used) with the free battery terminal; repeat the tests between A+ and the different battery terminals. If there is no sparking, and the tube will not light in any socket, it may be assumed that there are no shorts. If a "C" battery is used, its circuit should also be tested for a short.

(The test described is somewhat crude; if the constructor has a voltmeter, even of the cheapest kind, he can make a more satisfactory test. If he has headphones, a small battery—even a single cell—attached in series with them is an excellent and sensitive testing device. It will distinguish an open from a closed or short-circuit by the distinct click made when the phones are touched and removed from the terminals of the latter. The beginner will do well to familiarize himself with this form of testing as soon as possible.)

Another word of caution. The tuning condenser C1 has across it only the signal voltage, which is small at most; if it is defective, the only result will be that the set does not work. But the regeneration condenser C3 has across it 45 volts of the "B" battery and, especially if it is an old instrument, it is important to be sure that the plates do not touch when they are turned. The result of their doing so when the battery is connected will be highly undesirable.

OPERATION

After being assured of all these things, put good tubes in each socket; connect the "A", the "B" and (if one is used) the "C" batteries in the proper manner. The "B" battery is tapped at the proper voltages for the two or three binding posts, and its negative terminal is connected to that of the storage or "A" battery, or directly to the "A—" post. The aerial post is connected to the lead-in and the ground post to a suitable ground, such as a cold-water pipe, or what have you? The aerial, including its lead-in, may be of any length, usually 75 to 100 feet, with its horizontal portion as high and free from surrounding objects as possible. The longer it is, the greater the pick-up and sensitivity; the shorter it is, the greater the selectivity. The set owner must find for himself by experiment the antenna system which is most satisfactory in his particular locality.

Connect the speaker (or phones) to the speaker posts, and turn on the rheostat. Then rotate the dial until a signal is heard. (If there is none, and you know that locals are on, see where the "B" circuit is open or where the coil connections are reversed.) Bring the signal up to its maximum strength by turning C3, and then turn down the rheostat until the volume is about to fall off sharply. The receiver is now in normal operation.

A vernier dial has been specified because this set tunes very sharply, and it is necessary to have fine control of the tuning. However, if the reader wishes to use a plain, old-fashioned dial, he can obtain a vernier effect by pressing the rubber eraser of a

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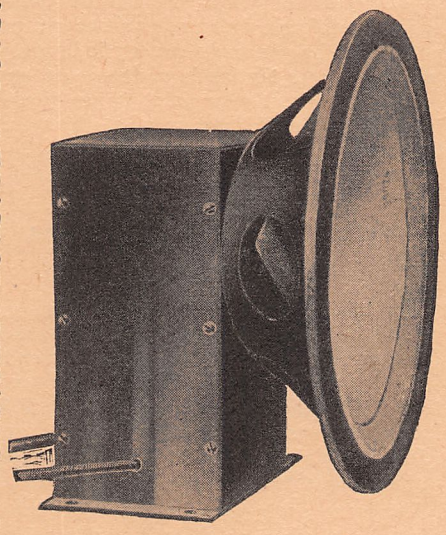

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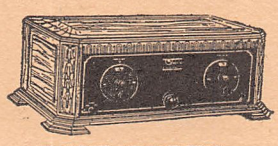

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pencil against the panel and the edge of the dial, and slowly turning it. This gives a very fine control of tuning and reduces body-capacity. If the latter effect is troublesome with the circuit as described (because the rotor of the tuning condenser, which is connected to the filament circuit, is connected to "A+" instead of "A—" and is therefore several volts above ground potential) the user may remedy it by pasting tinfoil over the inside of the panel, and connecting this at some point to the ground lead. This tinfoil must not be allowed to touch any other wiring or metal part.

Volume-Control Methods

(*Continued from page* 1001)

For this reason, series plate resistors are not advisable and resistors in the grid circuits (except in the first, when a resistor is used to couple the first audio-frequency tube to the aerial) are unsuitable. This leaves plate-control methods which do not affect the plate voltage, and the two aerial methods mentioned above.

Receivers using the filament-type tubes present a much more difficult problem. The balance in the filament and plate circuits must not be disturbed in any way. Any change in the plate voltage or the electrical balance in the filaments will cause a large increase in the hum and, when several stages of amplification are employed, this hum will become excessive.

There are four methods which are satisfactory; for small sets, or sets enclosed in shields, the two aerial-coupler methods are suitable. Of these, that shown as B (Fig. 4) is most satisfactory because of the greater amplification. The third, shown in Fig. 5 at B, employs a resistor which should be shunted across the secondary of the first tube, rather than in a subsequent stage. In the last method, shown in Fig. 3 at B and D, the resistor should have a value of about 10,000 ohms. If the first of these (3B) is used, the tuning condenser in the succeeding stage should be equipped with a midget condenser in order to keep the dial settings alike for each stage.

SCREEN-GRID SETS

Although screen-grid receivers might be classed under the general heading of battery sets, some special problems are encountered and, for this reason, it is advisable to treat these circuits separately. The extreme amplification gained in the radio-frequency amplifier will prevent some of the above control systems from operating effectively; while the universal use of shielding in screen-grid amplifiers will allow the use of some systems which are not suitable for ordinary sets. Audio-frequency control methods are not advisable, because of the trouble with overloaded detectors. This is even more evident in screen-grid sets, because of the higher voltages supplied to the detector by the radio-frequency amplifier.

The series plate-resistor method described above is not practical for two reasons. In the first place, it is not advisable to change the plate potential and, in the second, the volume may not be reduced sufficiently, even when the "B" voltage is cut down. This is most evident in sets with more than one stage of screen-grid amplification, when the volume control is not in the last stage. The shunt-resistor system of Fig. 3B could be used, but 3D will be better in most cases.

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The control should be placed in the plate circuit of the last radio-frequency amplifier.

The two aerial control methods in Fig. 4 will be quite satisfactory, because screen-grid sets are almost always shielded carefully. The grid methods of Fig. 5 could be used, but are less desirable than the other two methods mentioned above.

RESISTANCE VALUES

The resistance values required for the different systems of volume control vary considerably and, for this reason, it may be of some assistance to give the (approximate) maximum values required for the different systems.

Fig.	*Arrangement*	*Resistor Value ohms*
3A	Series R.F. plate lead	200,000
3B	Across R.F. primary	10,000
3C and 3D	Potentiometer shunts primary	20,000
4A	Series aerial potentiometer	10,000
4B	Shunt aerial potentiometer	25,000
5A	Grid circuit potentiometer	500,000
5B	Grid-shunt resistor	500,000

Because of the difficulty in obtaining smooth and efficient volume control in sets using several stages of radio-frequency amplification, it has been suggested that several resistors be coupled together and controlled by a single knob. If resistors are used in similar positions in the set, there is no reason why several instruments cannot be controlled in this way.

Volume controls other than resistors have been used sometimes. In one case, a copper tube was arranged to slide over the primary of one of the radio-frequency transformers. This method supplies a noiseless volume control; but it changes the characteristics of the primary and, through this, the secondary. Of course, this affects the tuning and is not suitable for single-control sets. Other methods have been suggested from time to time, but resistors in one or more of the positions outlined above are usually employed. In most cases they are quite satisfactory, and they are much simpler than the others.

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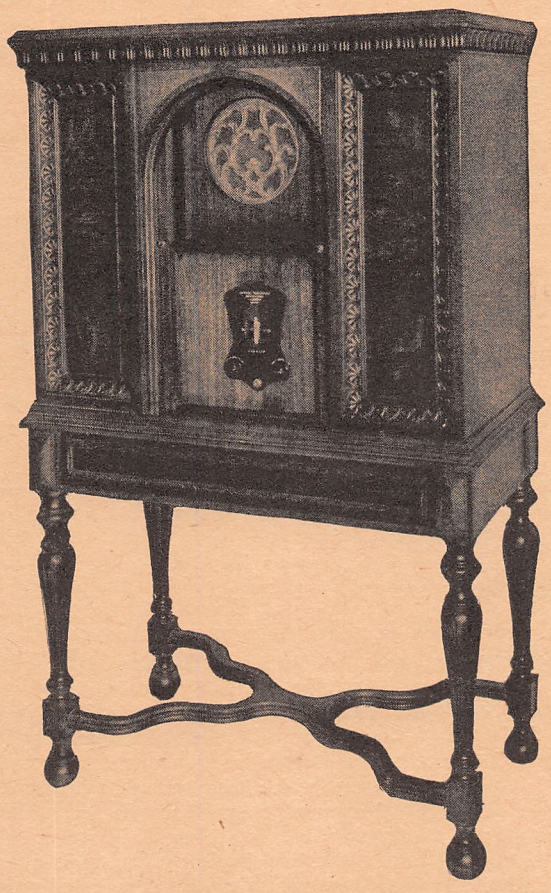

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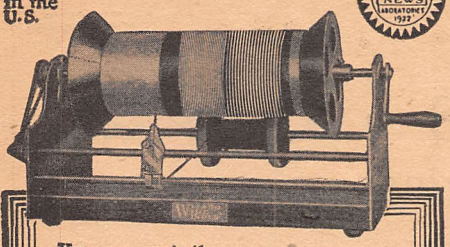

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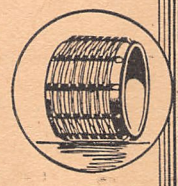

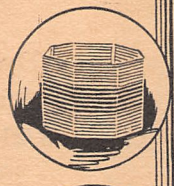

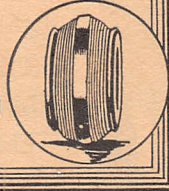

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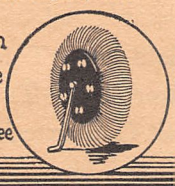

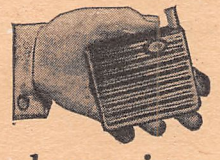

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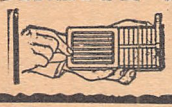

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Wavemeter Hints for the Short-Wave Listener

(*Continued from page* 1017)

should be quite strong and they are, without any great doubt, the correct ones. However, listen on each side of them to determine whether any more are very close, always referring to the table for the wavelength values. Perhaps a few weak signals may be heard; but the exact harmonics are strongest and any others that may appear may be disregarded. These will usually disappear if the coupling between the receivers is reduced. Being quite sure that these are

A simple method of construction is to put the wavemeter in a wooden box, on the back of which the plug-in receptacle is substantially mounted.

the true harmonics, (detune the broadcast set to see if they disappear) transfer them to the wavemeter. These points, and W2XAL's wave, constitute the starting points of the whole procedure. One can obtain additional checks on one's work by using other broadcast stations, as may be seen from the table.

CALIBRATION OF HARMONICS

The harmonics of the broadcast station can easily be calculated by simple arithmetic. The *fundamental,* or assigned frequency of the station, is its first harmonic. Half of this wavelength corresponds to twice the frequency, which is the second harmonic. The third harmonic, three times the fundamental frequency, has one-third of the wavelength, etc. When this simple division work is completed, the values are listed on ruled paper. A set of such values which were used for this purpose, follow. The reader must make up his own for the stations available to him.

Station "X" Broadcast wave 361.2 meters		Station "Y" Broadcast wave 428.3 meters	
No. of Harmonic	Wavelength Meters	No. of Harmonic	Wavelength Meters
1st	361.2	1st	428.3
7th	51.6	8th	53.54
8th	45.15	9th	47.59
9th	40.13	10th	42.83
10th	36.12	11th	38.94
11th	32.84	12th	35.69
12th	30.10	13th	32.95
13th	27.78	14th	30.59
14th	25.80	15th	28.55
15th	24.10	16th	26.77
16th	22.58	17th	25.19
17th	21.25	18th	23.79
18th	20.07	19th	22.54
19th	19.01	20th	21.42
20th	18.06	21st	20.40
21st	17.49	22nd	19.47
22nd	16.42	23rd	18.62

It is not necessary to calculate all the harmonics; in the above, the second to sixth inclusive have not been calculated because they are not used.

Three points are known on the chart, and should be plotted as shown in Fig. 4, at "A," "B" and "C." It is more convenient to use a straight-line-wavelength or straight-line-capacity condenser for this work. In this article it is assumed that a straight-line-capacity condenser is used; as this type is usually found among spare parts; such a condenser will be found to give a curve like that in Fig. 4. This diagram shows the calibration-curve being prepared for the wavemeter.

Say that W2XAL (or whatever short-wave station is used, when "clicked" with the receiver, comes in at 50 degrees on the

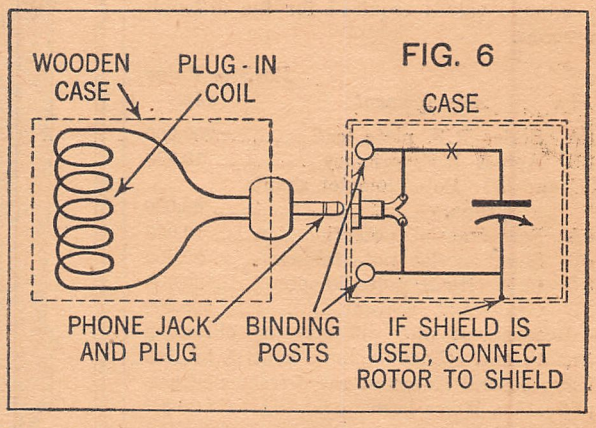

FIG. 6

wavemeter. Plot this point, using the 50 degree and the station's known wavelength at "A," as shown in Fig. 4. Assume that the 30.1-meter harmonic tunes in on the wavemeter at 40 degrees; this wavelength is obtained from the table.

Plot this point as at "B." The next harmonic, 27.78 meters, is noted at "C." A straight pencil line is drawn through the two upper points, as shown. The procedure is the same over any wavelength range.

COMPLETING THE CALIBRATION

With these points and the line just drawn, the other harmonics are located. In the table it is seen that the next harmonic has a wavelength of 32.84 meters; 32.8 is located on the lower axis and, by proceeding to the curve vertically, we find this corresponds to 70 degrees on the wavemeter dial. Set the wavemeter dial at 70 degrees, and increase the wavelength of the receiver until the familiar click is heard. The 32.8-meter harmonic will

(*Continued on opposite page*)

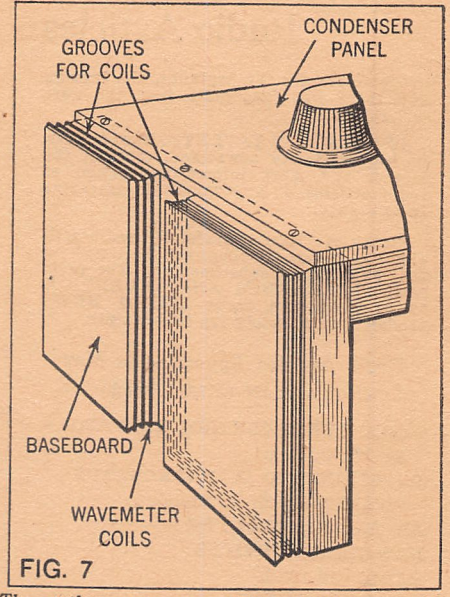

FIG. 7

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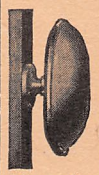

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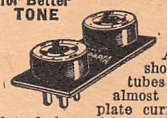

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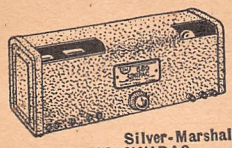

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(*Continued from opposite page*)

be found very near this estimated position. Tune it in, and note the wavemeter setting as before. Actually, the correct point may be slightly off the line, as shown at "D." If another station is used, another point such as "E" may be located, but ordinarily one station is sufficient. The original line should be erased and another drawn through the correct points thus located. The wavemeter is thus calibrated for this range.

ADDING OTHER RANGES

Calibration-charts for lower ranges may be prepared in a similar way. A smaller coil is substituted in the short-wave receiver and, by means of the wavemeter which has just been calibrated, one can locate known wavelengths on the receiver dial. When some known points are located by using the new receiver coil, the new coil can be used in the wavemeter, and a new chart prepared.

The coil should be so selected that some of the lower values in the first calibration-curve will fall at the "top" of the next curve to be determined; in other words, the ranges using the two coils "overlap." Thus a line on the new calibration-chart can be extended downward and approximate dial settings for the receiver determined to locate approximately even higher harmonics. These are tuned in as before, and transferred to the wavemeter. The curve is then completed, as already described. The system is more sensitive when two stages of audio amplification are used on the short-wave set. At the shorter waves, the broadcast receiver should be placed closer to the short-wave receiver, because its harmonics are feebler.

An ordinary five-plate condenser, or its equivalent, in the wavemeter, is quite satisfactory for general short-wave use, and gives good accuracy. The inductance in a wavemeter circuit, together with the distributed capacity of the coil and minimum capacity of the condenser, determine the "starting point" from which the variable condenser tunes as its plates mesh; and this is always toward lower frequencies or higher wavelengths. To make a given wavelength come in lower on the dial of the condenser, increase the inductance. When using space-wound coils (three inches in diameter, of No. 20 wire with eight turns to the inch; for details of construction, see September, 1927, RADIO NEWS) the following values will be found correct with a three-plate size; a five-plate condenser will cover a larger range. (*Continued on page* 1040, *following*)

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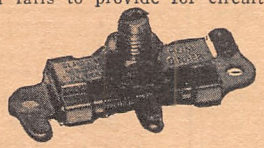

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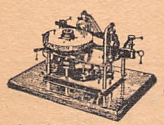

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Wavemeter Hints for the Short-Wave Listener

(*Continued from preceding page*)

No. of Turns	Wavelength Range Meters
13	26-40
8	20-30
5	14-24

If in doubt as to the sizes to use for other ranges, use the same, or nearly the same, size as used in the receiver to cover the particular range. The above values overlap so that a complete and convenient calibration may be had. When the spaced-turn coils are used, one can tune to a fraction of a dial-degree, so good accuracy is obtainable. With purchased short-wave coils, a condenser of the capacity specified by the manufacturer should be used as the tuner.

The construction of short-wave wavemeters is quite simple. Details of some easily constructed types are given in accompanying illustrations. One should make a wavemeter circuit as "low-loss" as possible, so tuning will be sharp; greater accuracy is then obtainable. Obviously, the parts should be mounted ruggedly, so that there will be no change in dial settings after the meter is calibrated.

Each short-wave fan has his own ideas about constructional details, and it would be interesting to see, at one time, all the different interesting modifications that RADIO NEWS readers will evolve.

How to Increase Selectivity

(*Continued from page 997*)

shielding must be insulated very carefully from the wiring and apparatus (except ground leads) to prevent short circuits in the filament or plate wiring.

WHAT THESE DO NOT HELP

None of these remedies, of course, go to the point of curing interference which is caused by two or more stations operating simultaneously on the same frequency under the present allocation. For any receiver within range of both broadcasters, and where the nearness of one does not give it overwhelming strength, the only possible means of separating them is by using a directional antenna, such as the loop. The advantages of a loop, of course, (which is a tuned antenna of high efficiency) are nevertheless decreased by its small area, if it is to be conveniently handled; and it requires about a stage of screen-grid or two of ordinary R.F. amplification to make up fully for this, on feeble signals.

All the methods described which diminish the interference of a strong local signal do so by *decreasing the sensitivity* of the receiver outside the narrow band to which it is tuned; and the importance of good construction comes in here. Resistance in any circuit broadens tuning. At the same time, a circuit which is tuned too sharply so decreases in sensitivity at even 5,000 cycles away from the resonant frequency that it "cuts the sidebands" of the modulated carrier-frequency which it is receiving; and thus impairs the quality of the reproduced voice and speech. To avoid this, the "band-pass filter" circuit has been developed; but its construction requires matching with laboratory instruments.

"STATIC"!!!

Natural "static," or more properly atmospherics, we have still with us, notwithstanding that the daily news dispatches have just announced the 1,000,002nd invention of a device completely eliminating this bugbear. Such waves of broadcast frequency as are created by atmospheric disturbances enter into and combine directly with the received signal; so that the endeavor to filter them out is like one to make a filter which will take out the sounds of a panful of dishes being dropped in front of the microphone. Such a filter might be made, but it would have to take out of the receiving system its sensitivity to a wide range of sounds. So every static-reducing system lowers the sensitivity—or the amplification—of a set for some other things besides static. Again, however, the theoretical value of the loop is high.

The numerous forms of "man-made static," due to the numerous electrical appliances of all kinds which make and break electric circuits, and consequently send out trains of waves, fall into another category. The remedy for these is at the source, however; and the same is true of the radiating regenerative receivers, or "bloopers," which are really unlicensed transmitters working in the broadcast band. Their tribe, it is to be hoped, is steadily decreasing; just as are various other former utilities which were good enough in pioneer days and out in the great open spaces; but which have become public nuisances where population is dense and the rights of others require respect.

TWO FOR A NICKEL, NOW

GENERAL STORE PROPRIETOR: "Well, sonny, what can I do for you?"

SMALL BOY (*looking around*): "I want to get a whistle."

G. S. P.: "What kind, big or little?"

S. B.: "I want one of those het'rodyne whistles, if I can get one for ten cents."—*Charles F. Akerman.*

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TUNE IN ON WRNY

How to Deal With "Man-Made Static"

(Continued from page 999)

set user, section seven has been written with the view to placing it in force with the acceptance of the law.

We daily receive reports of ordinances which have been passed by various municipalities. For the convenience of our friends we have had printed copies of ordinances passed by cities and towns, among

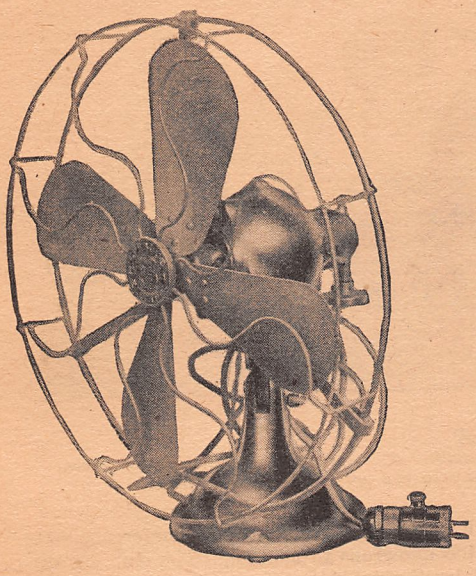

Fig. A

The necessary electric fan is harmless when the interference from its motor is cut off from the light-line by a small filter plug.

which are: Fairfield, Ia.; Boonville, N. Y.; Warsaw, Ind.; Bay City, Mich; St. Paul, Minn.; City of Two Harbors, Mich.; Portland, Ore.; Drumright, Okla., and Los Angeles, Calif. These may be had upon request, as well as the Maine state law, which penalizes radio interference.

PROPOSED LAW

"*Sec.* 1. As hereinafter set forth, it shall be deemed unlawful to manufacture, sell, operate or cause to be manufactured, sold or operated any electrical, mechanical or other apparatus of any description which will create or cause to be created an electrical or other disturbance which will be received by a radio receiving set and transmitted to the output of said set so as to interfere with the transmission or reception

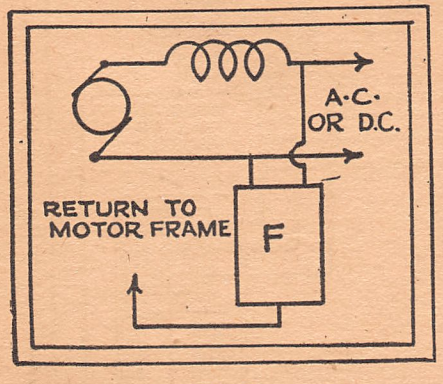

Fig. 1

Filter condensers "by-pass" or absorb high-frequency components in the output of a generator; but not the 60-cycle current.

of radio transmission or broadcast between 100 and 600 meters.

"*Sec.* 2. The operation of any and all electrical, mechanical and other apparatus which will create or cause to be created an interfering electrical or other disturbance as set forth in Sec. 1 shall be deemed unlawful, if such disturbance is of sufficient intensity to interfere with the operation of a radio receiving set of standard construction to such an extent that the radio reception of said receiving set shall be interfered with or impaired when receiving broadcast or other reception between 100 and 600 meters.

"*Sec.* 3. Effective (date), all manufacturers of electrical apparatus or other apparatus which may be the cause of an interfering disturbance as herein set forth are hereby notified that it shall be deemed unlawful to sell or give away or cause to be sold or given away any interfering apparatus unless said apparatus is so changed that it will not cause an interfering disturbance, with the exception that it is sold or given away with the understanding that the user or operator of said apparatus will install proper interference-suppression devices so that the combination thereof shall comply with the law.

"*Sec.* 4. Effective (date), all distributors or vendors of electrical apparatus or other apparatus are hereby notified that it will be deemed unlawful to sell or give away or cause to be sold or given away any apparatus which does not comply with the law

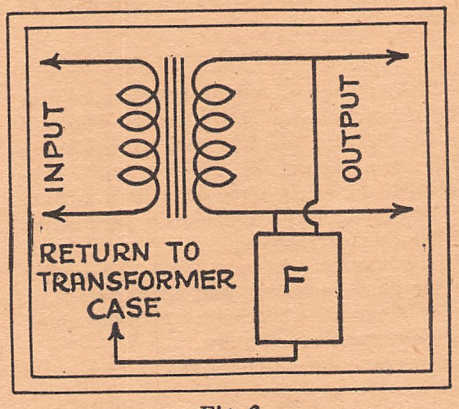

Fig. 2

A power transformer may be a source of trouble unless it is by-passed with a filter of the appropriate value, in this manner.

as herein set forth in Secs. 1 and 2; with the exception, as set forth in Sec. 3, that the user or installer of said apparatus agrees to install said interfering-suppression apparatus in such a manner that the combination thereof will comply with the law.

"*Sec.* 5. Effective (date), all owners, users or operators of electrical or other apparatus which may cause an interfering disturbance as herein set forth in Secs. 1 and 2 are hereby notified that it will be deemed unlawful to use or operate or cause to be used or operated any interfering apparatus, unless said apparatus is changed so as not to create any radio interference as herein set forth or additional interference-suppression apparatus is provided, so that the combination thereof will comply with the law.

"*Sec.* 6. Effective (date), all manufac-

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turers, distributors or users of electrical energy are hereby notified that it shall be deemed unlawful to distribute or use or cause to be distributed or used electrical energy in any form which would create or cause to be created an interfering disturbance as herein set forth in Secs. 1 and 2.

"*Sec. 7.* Effective (date), all owners, or operators of electrical or other apparatus which may cause an interfering disturbance as herein set forth in Secs. 1 and 2 are hereby notified that it will be deemed unlawful to use or operate or cause to be used or operated any interfering apparatus between the hours of 12 noon and 12 midnight; with the exception of permanently-installed apparatus, such as heating equipment or other apparatus, restriction of which would cause a hardship on the owner or user, and which must be corrected as in Sec. 5."

CO-OPERATIVE EFFORTS

While many owners of interference-producing devices are also listeners who will be the first to see the need of equipping their own household utilities with suppressors, for their own sake, it is certain that to bring about a wholesale purification of the ether from electrical disturbances it will be necessary to have legislation similar to the above proposal, and accompanied by suitable executive machinery to bring about an enforcement of the law.

However, the listeners must take their own part; unorganized, they can only suffer in silence but, when united, they are in a position to enlist the aid of the authorities in their behalf; to investigate the causes of interference and either to enlist the co-operation of the owners of apparatus or to compel it; to obtain publicity from the press and from broadcasters for their work; and in many other ways to improve reception and increase the value of radio to themselves and to their cities.

As an example of what may be done, the case of the Lackawanna Radio Club of Scranton, Pennsylvania, may be cited out of the many which have been brought to our attention. This club, organized three years ago, has now over 2,000 members; its dues are two dollars a year, which have been richly repaid in improved reception. When it began in 1925, causes of interference were too numerous to mention. The club has employed a trouble-shooter of its own, on part time, to investigate sources of interference reported by its members. One-half of the club revenue was devoted directly to this work and remedial action. The Scranton Electric and Scranton Railway companies have co-operated, assigning each a trouble-shooter to a like job. The local traction company has taken steps to equip every street car with an interference eliminator, which will remove one of the greatest sources of complaint. Ice-cream and other manufacturers have put suppressors on their apparatus; oil-burning furnaces have been located and made harmless from a radio standpoint. Regenerative sets have been located, and (in a friendly way) their operators have been instructed how to avoid annoying the neighbors. As a final aim of the club is set down, "To assist in obtaining

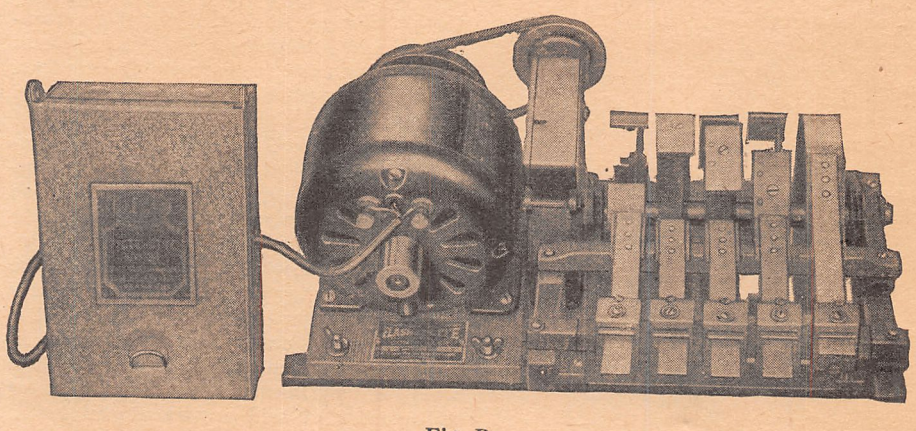
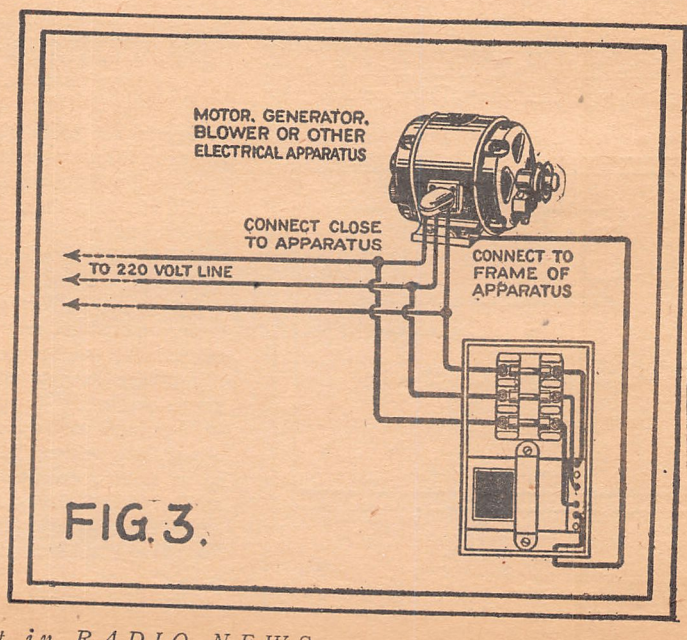


Fig. B

The flashing-sign equipment is almost an ideal transmitter of disturbances, as the neighbors know. Properly filtered, however, the sign will be seen and not heard, as it should be.

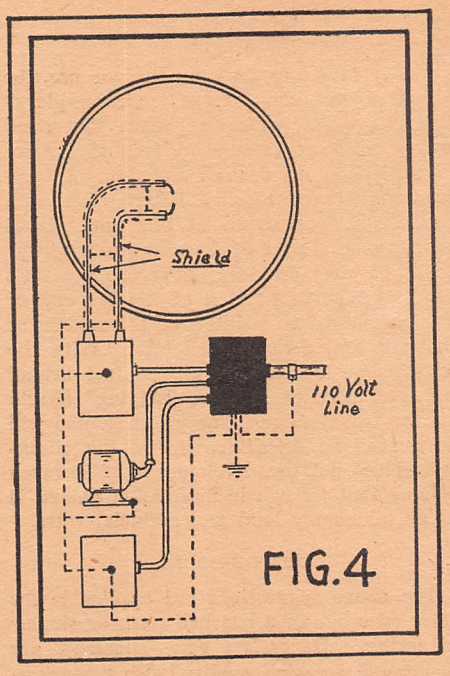

MOTOR, GENERATOR, BLOWER OR OTHER ELECTRICAL APPARATUS
CONNECT CLOSE TO APPARATUS
TO 220 VOLT LINE
CONNECT TO FRAME OF APPARATUS
FIG. 3.

Larger apparatus than that of the household requires filters of greater power rating, and consequently larger size. Such filters are provided in metal cases for permanent installation. Both generators and motors require them, to produce electrical quiet along the power line.

efficient radio laws and aid in the enforcement of the same."

Among the different causes of radio interference are, in the household, the many small motors used for various purposes (vacuum cleaners, fans, kitchen appliances, sewing machines) and the spark circuits of oil burners. In business houses and professional offices, the motors are the principal source of trouble, as well as the sign-flashers which are really transmitters often of considerable size. Manufacturing concerns have dynamos and motors of all sizes, and power transformers which can often cause trouble. For smaller equipment, in the wide range of interference suppressors now found, there are now ample ready-made remedies. Large installations may require special designs. But, as said before, these are matters of detail. Man-made interference *can be cured;* it is necessary only to have public sentiment aroused to the point of demanding that it *shall* be. The writer bespeaks the co-operation of every radio fan, as well as of all who are in the radio industry and trades, in this crusade; and will gladly lend his utmost toward assisting in every effort to this end.

(*Readers desiring to address Mr. Deutschmann for the model ordinances and other campaign material he offers may do so, at Canton, Mass.*—EDITOR.)



The oil-burning furnace is a source of comfort to the radio listener only when muzzled. An interference filter will take care of the ignition, the motor, the heat regulator; but in difficult cases shielding may be needed.

Public-Address Systems

(*Continued from page* 991)

Where such an amplifier is used to operate up to twelve loud speakers in different rooms of a building, the loud speakers should be connected as shown in Figure 2. For each speaker a wall outlet plate, carrying a 3,000-ohm wire-wound potentiometer and open-circuit jack should be provided. With the proper output transformers this arrangement will provide ample volume for home or class-room purposes, with independent volume control at each speaker outlet, and a substantial constant volume level, whether one or twelve outlets are in use.

AUDITORIUM USE

For auditorium or theatre use, one or two large speakers, such as thirty-six-inch cone speakers, may be used placed close togther, or not over ten to fifteen feet apart at most. Through careful trial, the speakers should be so tilted and directed as to give intelligible speech and music throughout the auditorium. This treatment will suffice for a hall not over half again as long as it is wide; though for a very large hall (say 100x150 feet) three or more speakers might prove necessary.

If dynamic speakers are preferred, they may be used if of the low-voltage, trickle-charger-operated-field type. If two speakers are used, series and parallel connections should be tried. Three speakers should be connected in parallel; four, in series-parallel. *Speakers should be so placed that the microphone, if one is used, is always well behind a line crossing the mouth or openings of the speaker.* For auditorium installation, to intensify a speaker's voice, only a double-button type of microphone should be used, and the loud speakers should be swung above the speaker's head, and far enough

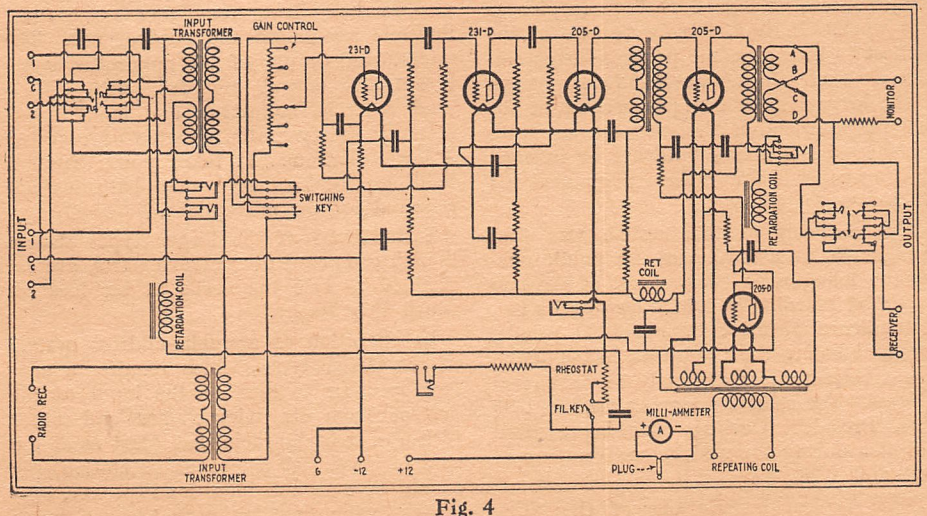


Fig. 4

Here is the typical schematic circuit of a Western Electric address amplifier, using tubes and special apparatus, which will perhaps be unfamiliar to our readers. It has a five-watt output.

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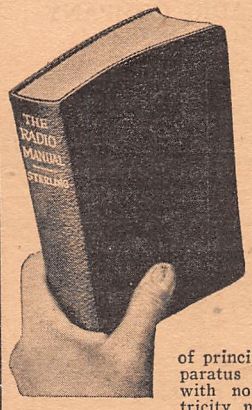

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16 Chapters Cover: Elementary Electricity and Magnetism; Motors and Generators; Storage Batteries and Charging Circuits; The Vacuum Tube; Circuits Employed in Vacuum Tube Transmitters; Modulating Systems; Wavemeters; Piezo-Electric Oscillators; Wave Traps; Marine Vacuum Tube Transmitters; Radio Broadcasting Equipment; Arc Transmitters; Spark Transmitters; Commercial Radio Receivers; Radio Beacons and Direction Finders; Radio Laws and Regulations; Handling and Abstracting Traffic.

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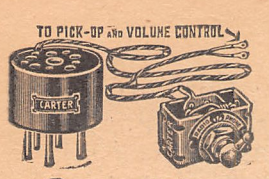

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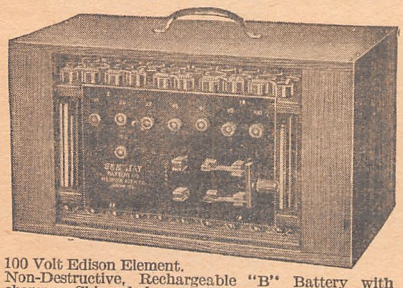

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Non-Destructive, Rechargeable "B" Battery with charger. Shipped dry, with solution, $12. 140 Volt with charger, $17. 180 Volt Power Unit, with Trickle Charger, $24.00.
SEND NO MONEY—PAY EXPRESSMAN
Write for our Free Literature
SEE JAY BATTERY CO., 915 Brook Ave., New York

away to allow the desired volume to be obtained without "singing."

For a very long hall, or outdoor use, the long-horn speaker (of the "morning-glory" type) is often preferable, since the sound waves can be radiated away from the microphone and in any desired direction. A typical installation for a hall 100x200 feet, with the speaker's rostrum at one end, would consist of a cluster of four "morning-glory" horns ten feet or more above the speaker's head, two horns pointed at the far end of the hall, and two pointed at the middle of the hall and diverging slightly. With the microphone located five to ten feet behind the loud speaker mouths, "singing" should not be troublesome. The effect gained will be a realistic *intensification* of the speaker's voice—not the development of so much *volume* that the whole impression gained is of an inhumanly loud and artificial voice.

OUT-OF-DOORS

The above suggestions are applicable for voice coverage of a baseball park or similar gathering. Generally, cone speakers are preferable for high quality, with "morning-glories" used only to avoid "singing" due to the loud speakers' reaction on the microphone; or in order to project sound waves in one direction. When voice coverage is not needed, and radio or record reproduction only is desired, cone or dynamic speakers are to be preferred. Speakers should never be left out of doors for long periods, for dampness will deteriorate them. When they are installed out of doors an adequate canopy must be provided to protect them from rain and dampness. Microphones must be most carefully protected from moisture.

For occasional voice announcements to be made between musical selections, a hand microphone is quite good enough for intelligible speech. For amplification of entire speeches or addresses, where high quality is desired, the double-button microphone should be used, and a switch provided to cut off the microphone battery when not in use.

LARGE PUBLIC-ADDRESS SYSTEMS

The Western Electric Company, on account of its experience in the telephone field, naturally became one of the pioneers in the development of a public-address system. Having already applied speech amplification to the transcontinental and other long-distance telephone communication, this company was in a good position to pioneer this work. In fact, they were one of the earliest to introduce the public-address amplifier. Their No. 1A public-address system is the largest piece of equipment made for this purpose and is designed for use with the largest audiences, outdoors or indoors. It is adapted for either permanent or temporary installation.

The efficiency of this system was first brought to the attention of the public during the inauguration ceremonies of the late President Harding in 1921, when, by its use, an audience of more than 125,000 people, gathered before the Capitol at Washington, was enabled to hear distinctly the inaugural address. The same system was used in 1925 when President Coolidge was inaugurated and also during the national conventions of 1924 and 1928.

Some typical installations of the W.E. public-address systems are shown here. Considering the amplifier panel in Fig. C, the upper right-hand portion is the volume-control panel supplied for use in connection with the amplifying equipment. It provides a means for adjusting the volume of sound from the different groups of speakers to fit the acoustics of the parts of the auditorium which they cover. By means of adjusting the rheostat knobs, it is possible to regulate the power supplied to the various speakers or projectors. Just below the volume-control panel is the volume-indicator panel. The meter at the extreme left of this panel gives a visual indication to the operator of the output volume of the system.

Next comes the amplifier panel proper with its horizontally-mounted tubes visible. The amplifying equipment receives the speech-frequency currents and amplifies this energy to a level high enough to permit its distribution through the loud-speaker projectors to the audience. It provides three stages of amplification and makes use of three vacuum tubes; one type 102-D having a very high amplification constant, and two 205-D type having a low amplification constant but a much greater power output. The amplifier is provided with suitable controls for regulating the amount of amplification. At the bottom, an intermediate (type 42) amplifier.

In the upper left-hand portion of the main panel illustrated in Fig. C is the high-power amplifier panel, which receives the amplified voice currents direct from the first amplifier. It supplies a single stage of amplification but makes use of four of the 211-type power tubes. These tubes operate on the push-pull principle, two tubes in parallel on each side of the circuit. The output of this amplifier is controlled by the amount of energy received from the first amplifier.

The two lower panels in the left-hand portion of the main panel shown in Fig. C are the power-control and the rectifier panels, respectively.

Though somewhat smaller than the No. 1A system, the 2A system is capable of taking care of large crowds either outdoors or indoors. The No. 2A system is at present being widely used in auditoriums and hotel banquet halls throughout the country.

The Western Electric 3A public-address system is suitable for use in auditoriums, the cubical contents of which do not exceed 150,000 cubic feet. A portable amplifier is used with this apparatus, as with the 4A.

Fig. A shows front and rear of a new rack-and-panel amplifier developed by Silver-Marshall, Inc., for large auditorium, multiple apartment and outdoor use. The undistorted output of the apparatus, using a PA-30A output amplifier, with associated controls, indicators, and input apparatus, is thirty watts, capable of covering a large stadium. It takes power from a lighting circuit, except that batteries are required for the microphone.

Installations of the larger types shown, though composed of standard parts, are assembled to suit the needs of the location which they serve.

In operation of a public-address system of the larger types, which requires a control operator to monitor the input of the system from its microphones and other pick-ups, it is desirable that (just as at the control panel of a broadcast station) he should have an individual loud speaker, connected to the amplifier, so that he can judge the program. For such a purpose, a small cone speaker is preferable.

"Junior Hi-Q 29"

(*Continued from page* 1011)

The wires should not be pulled taut after being passed through the holes. All potential sources terminate in the cable-connector plug.

OPERATING THE "HI-Q 29 JR."

With respect to the receiver's operation, special directions are unnecessary. In view of the use of only two stages of radio-frequency amplification, accurate resonance in each stage is necessary and accurate adjustment of the tuning dial is likewise essential, for both selectivity and tone quality. It is necessary that the operator bear in mind the phenomenon of "sideband suppression"; detuning of the R.F. stages in such a system results in the loss of low notes and lack of selectivity. The aerial employed may be of any outdoor elevated type but it should not be longer than 100 feet over all.

Correct adjustment of the operating potentials will aid materially in the attainment of good reproduction and satisfactory receiver operation. Excessive plate potenials applied to the radio-frequency amplifying tubes will augment the degree of regeneration in the system and thus reduce its inherent stability. Insufficient plate and filament potentials in the audio-frequency systems will mar the quality of reproduction, and increase the possibility of tube overloading.

Particular attention must be paid to the use of a 171A type of tube as the output tube. This tube draws approximately 20 milliamperes of plate current at 180 volts, and a speaker filter should always be employed, unless an output transformer is used to feed the speaker.

"A.C. Screen-Grid DX-er"

(*Continued from page* 1015)

the best thing to use when you have no back yard, or if you have one, but don't care to dig up a ton of earth. Some readers of RADIO NEWS will recall the extraordinary ground system used by a boy in Providence, R. I., who has heard practically every station on earth with a two-tube set. (See the issue of March, 1928). He buried old wash boilers, bathtubs, automobile radiators, and many other odd pieces of junk, and watered them all as regularly as if he were keeping a flower garden.

USE A VOLTMETER

Practically all power transformers designed for modern A.C. sets are intended for use on 110-volt power lines. However, the voltage in particular places may be considerably higher or lower than this figure—a fact many a service man will sadly verify. If the voltage is higher (as it usually is) you may experience no end of trouble from blown-out filter condensers and short-lived tubes.

The one and only way to determine whether the line-voltage is correct, and whether the tubes are receiving the proper filament voltages, is to use an A.C. voltmeter. The most popular instruments have three-scale readings: 0-4 volts, 0-8 volts, and 0-150 volts. Thus the one meter will read the filament voltages of all types of receiving tubes, including the rectifiers, and also the voltage of the line.

The D.C. voltages developed by the "B" power pack can be read accurately only with a high-resistance voltmeter. Ordinary, small battery voltmeters are worthless; as they require for their own operation almost as much current as will be drawn by the plate circuits of all the tubes, in the average set, and therefore give a reading entirely too low.

A model receiver assembled from a kit was tested by members of the RADIO NEWS staff both in New York City and in a farm house near Peekskill, New York. In both locations it produced unusual results.

The farm house was, naturally, the better location, because of the absence of the troublesome factors that make city reception so uncertain. During one evening of listening almost a hundred different stations were logged, two being on the West Coast. The Chicago stations figuratively "tore the roof off;" while those in San Francisco and Los Angeles were weak, though understandable. The quality was all that could be asked, the tuning sharp, the sensitivity very high. More could hardly be expected of any set, regardless of price; and this outfit can be built for less than fifty dollars.

NEW DOMINICAN STATION

SOME of our readers have already picked up HIX, the new 1,000-watt station just installed by the government of the Dominican Republic at the capital city, Santo Domingo; it has been heard to the south as far as the Argentine. We are informed by Senor Manuel E. Nanita, the director, that the wave is 447 meters (670 kilocycles) and the schedule from 7:40 to 9:40 p. m., E. S. T., on Tuesdays and Thursdays. The station houses also a radio-telegraph transmitter.

AN IMPROVISATOR

MRS. ELITE: "Has your son an advanced musical education?"

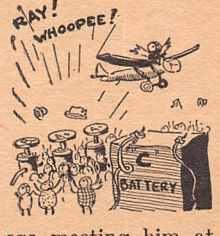
MRS. NURICHE: "You bet! He can tune any radio set a-going!"

—*Ted Hagedorn.*

A RADIO SOUVENIR

ALONG with the presidential chair, the presidential microphone stand now becomes a perquisite of that high office. President Coolidge, who has been distinguished for his radio effectiveness, has been presented by the N. B. C. with the reading desk which he used and which accompanied him on several tours. A second has been provided for the exclusive use of President Hoover, who also will certainly make frequent use of it.

A TRANSOCEANIC PIONEER



BUGVILLE ANNOUNCER: "This is station WBUG, Bugville. Mr. H. Fly, the great aviator, has just completed his successful flight over the "C"! The mayor's committee are meeting him at the Battery and will escort him to the Terminal!"—*R. Channon* (Australia).

CeCo Type J-71-A
—A 5-volt ¼ amp. tube for use in the output stage of audio amplifier. Handles 12 times the undistorted volume of the usual type A tube.

The tremendous and constantly growing demand for CeCo J-71 and J-71-A Power Tubes is due to two things—first, their capacity for handling greater undistorted volume, and second, making possible an unusually excellent tone quality under full load, clear to the end of their long life.

Inquire today about the interesting possibilities afforded by these well known CeCo tubes.

CeCo Radio Tubes

Listen in on the CeCo Couriers—on the air every Monday evening at 8:30 Eastern time (7:30 Central time) over the Columbia Broadcasting chain.

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"Operating on Our Assigned Radio Frequency of 610 Kilocycles . . ."

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Will Tell You!

Just turn the disk to the kilocycle or meter listed and the dial number wanted will show in the second window. *Be sure to mention the name and model of your set when ordering.* *Sent postpaid anywhere,* 25c.
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The "*New York Times*" Short-Wave Receiver

(*Continued from page* 1005)

on the two smaller couplers, which are made in the same manner as the primary. In cementing the wire to the celluloid, acetone or amyl acetate may be used. A strip of thin, clear celluloid is wound around a solid form of the required size. The wire is then wound over the celluloid (using any suitable means of spacing between the turns) and, after the spacing has been removed, a coat of the solvent is painted on the coil with a soft brush. This will soften the celluloid and, after it has dried, it will be found that the wire is solidly embedded in the form. The inner tube or form is then removed and the coil is ready for use. A space of ⅛-inch is left between the secondary and tickler of each of the coils. The diameter of each is 2 inches.

The second in size of the plug-in coils has ten turns in the secondary and five in the tickler, while the third and largest has a secondary of twenty one turns and a plate coil of nine turns. The latter, however, differs from the others in the size of the wire used; which is, in this case, No. 20 D.S.C. wire is employed. The spacing is equal to the diameter of the wire as with the other coils, and the space between the primary and secondary is the same—⅛-inch. In home-made coils, phone tips and phone-tip jacks may be used for the plug-in arrangement, or any other convenient method of mounting may be arranged.

TUNING THE SET

The tuning of the *New York Times* short-wave receiver is very much the same as with other short-wave sets. RADIO NEWS has published a number of articles on the subject of tuning and handling short-wave apparatus. One in particular, which appeared in the December 1928 issue of this magazine is of particular interest in the matter of handling a short-wave set. The article is entitled "How to Succeed in Short-Wave Operation," and will be found on page 552.

The only difference in the tuning of this receiver when compared to others is that the rough tuning is accomplished with the drum-dial, and the midget condenser is operated as an auxiliary control. When a station has been tuned in, after the set has been first connected up, the setting of the midget condenser should be noted. When the same coil is used at a later time, the midget condenser must be placed in the same approximate position. In most cases, the position of the condenser will be the same for all coils, if they are well matched; but in a few cases, the setting may be different for one of the coils than for the others.

When the set is first used, the positions of the various distant broadcast stations will not be known. However, we do know the approximate band covered by the different coils and from this, we can tell what stations we can receive with the various coils and at about what point on the dial we should hear them. In other words, we know that KDKA operates on 62.50 meters. According to the manufacturer, our largest coil covers the waveband between 52 and 107 meters with the specified condenser. Then KDKA should be very close to the lower end of the dial, with the two largest coils in their mountings. Similarly, the smallest set of coils covers the band between 15 and 30 meters and the intermediate set works between 25 and 59 meters. A list of short-wave broadcast stations (unfortunately incomplete, due to the impossibility of obtaining an official list) and their wavelengths and power will be found elsewhere in this magazine.

The regeneration condenser, which is governed by the knob at the right side of the set must be adjusted to obtain the correct amount of regeneration for each wave. Since the tendency of the set to oscillate varies over different parts of the scale and with different coils, this condenser must be adjusted continually together with the tuning condenser. (Further data on the methods of controlling regeneration will be found in the article mentioned above, "How to Succeed in Short-Wave Operation." The only other controls in the set are the filament resistors for the screen-grid and detector tubes. That controlling the detector tube is often a very useful regulator of the oscillation of this tube, when used in conjunction with the regeneration condenser.

Another point worth considering at this time is the aerial. This is a very important point in the operation of short-wave receivers and in fact the aerial can either "make" or "break" a set, so far as distant reception is concerned. An article covering this point very well will be found in the April issue of this magazine. The reader is advised to read this article very carefully before building any receiver for short waves.

The subject of power supply for short-wave receivers is often brought up in the letters we have received inquiring about our receiver. The filaments of the tubes are lit in the conventional manner, with a storage battery. The plates are also actuated from a battery source, since it was found that this is much more satisfactory than the use of power units. The builder is urged to use batteries for both filament and plate supply, in order to obtain the greatest satisfaction.

ROBERT E. LACAULT, for several years Managing Editor of RADIO NEWS, has completed all of his radio activity. Mr. Lacault, who was recognized as one of the leaders of radio in this country and who, during the war, did a great deal of development work under the personal direction of General Ferrie of the French Army, was responsible for a number of very valuable contributions to the radio art. The Ultradyne Receiver was one of his outstanding achievements, and will be remembered by many of our readers.

Mr. Lacault, who passed away on March 12, 1929, is survived by his widow, Mrs. Alice M. Lacault, who contemplates continuing the radio business started by Mr. Lacault upon his resignation from the staff of RADIO NEWS.

We know that we are expressing the feelings of a great many of our readers in extending to Mrs. Lacault our heartfelt sympathy.

Radio Wrinkles

(*Continued from page* 1021)

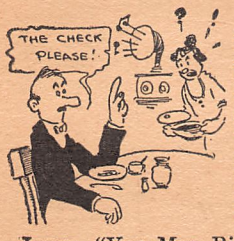
from the large transmitters, and the set may be tuned much broader, thus obtaining better quality.

The accompanying diagram (Fig. 7) is self-explanatory; the secondary coil being wound on tubing according to specifications. The primary is wound on a slightly smaller tube and contains several more turns than are specified for this coil. This coil is supported on a piece of bakelite or hard rubber, which is hinged at the bottom where it is fastened to the baseboard; the size of the insulating strip depends on that of the tubing used.

The adjusting feature comprises a brass angle, fastened to the base and having a hole threaded through it near the top. The height of the angle depends also on the size of the tubing in the coils. It should be slightly higher than the center of the primary coil. (If it is not possible to thread the angle, a nut may be soldered to it.) A screw is placed in the threaded angle and serves to push the primary coil toward the secondary. A spring or a rubber band is fastened, as shown, to the primary coil support and the threaded angle, to bring the primary coil back when the adjusting screw is withdrawn.

The secondary coil is mounted on threaded supports or angles in the usual manner; the primary coil may be fastened to the hinged bracket in any convenient way. Probably the easiest method is to fasten two small angles to the support and drill two holes in the coil form; small machine screws will serve to hold it in place. —*Contributed by L. H. Lester.*

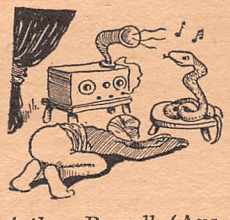
POWER OF IMAGINATION



BINKS: "My radio is a wonderful reproducer. Every night, when we turn on the dinner music from the Van Ritz, we seem to be dining right there in the hotel."

JINKS: "Yes, Mrs. Binks told me that you even left fifty cents under your plate the other night!"—*Wm. G. Mortimer.*

SNAKES OR STATIC?

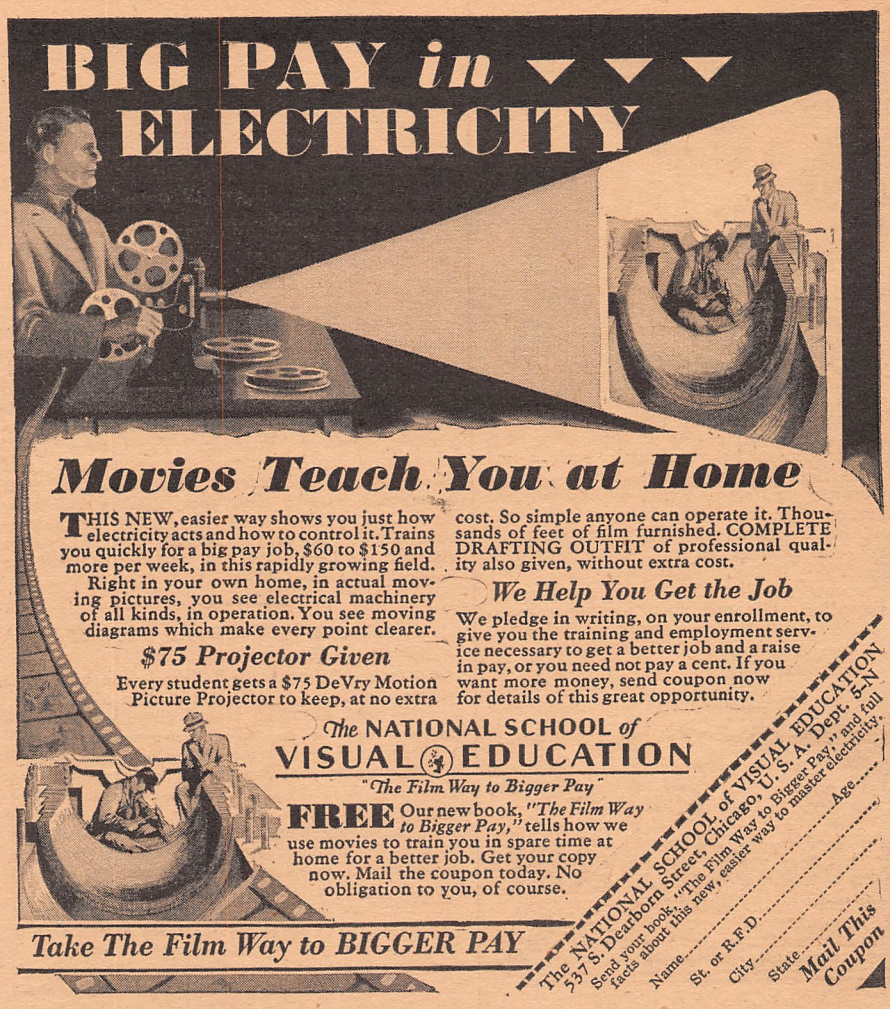


An advertisement appearing recently in an Indian journal expressed a want for a person to fill the position of chief snake charmer to a respectable family, and radio companion for a boy of eight.—*Arthur Russell* (Australia).

TUNE IN "A GARDEN OF ROSES"

REPORTER (*of the inquiring variety*): "Doctor, what do you think will be the next great development after radio and television?"

GREAT INVENTOR (*prophetically*): "Smellivision, of course."—*V. W. Taylor.*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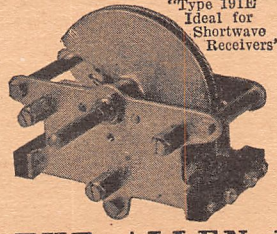

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Cardwells are sturdy, vibrationless, hold their calibration indefinitely and the purchase price includes satisfaction insurance.

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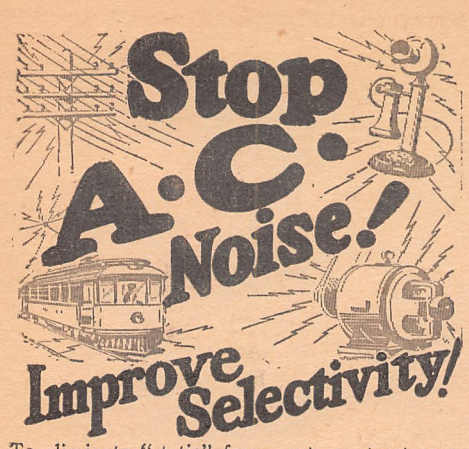

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Factory to you. Save 50% on latest AC Electric or Battery Radio. Free return privilege.
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Radio's most amazing bargains direct from big, old, reliable maker. Don't buy unless 30 days' use proves entire outfit unbeatable at 2 to 3 times the price, for tone, selectivity, distance, volume.
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CHAS. HOODWIN CO., 4240 Lincoln Ave., Dept 524 Chicago
Dealers in Bankrupt Radio Stocks

Radio "Mysteries"

(*Continued from page 994*)

AT LAST!

Editor, RADIO NEWS:

The following is an account of a real "radio mystery" told to me by my mother. She said that, about Feb. 15 last, she was crossing the Hackensack "meadows" just outside of New York City in an interurban bus; she heard *code* that seemed to be coming out of the windows, or the framework near them. The phenomenon continued for about a minute and then stopped.

J. R. HARRISON, JR.,
Upper Montclair, N. J.

(We have been waiting for this. A good many people have been hearing voice and music from odd sources; but, in view of the number of stations both above and below the broadcast band pouring high-power telegraph transmissions into the ether, it might be expected that some "mysteries" should be in code. Those who "hear" illusions of hearing have so far not been troubled by anything but broadcast transmitters; the most convincing reply to those who maintain that some exceptional persons may be capable of hearing radio itself. As to the incident reported, unfortunately we have no means of learning what the code message was.—EDITOR.)*

AN ODD TELEPHONE PICK-UP

Editor, RADIO NEWS:

Speaking of "mysteries," here is one to add to your collection. I have built a number of receivers, starting with the usual crystal circuits, and working my way up to 8-tube loop-operated, Lacault superhet (my present outfit) without noticing any startling radio reactions in my constructional experiences. You say that line-wire conversations are often heard on the loud speaker, due to grounded circuits, among other reasons. This is true, but how do you account for my reception of telephone conversations when my receiver employs a loop antenna and, as far as I know, is not grounded? The telephone line runs parallel to my home and is 66 feet from my loop. Another queer fact is that I cannot pick up any conversations unless I tune into a carrier-wave; whereupon the voices are heard with none too much volume. I tune to about 526 meters, place my set's loop parallel to the line, tune in a carrier, and the operation is complete.

GUSTAVE YELM,
Genoa, Nebraska.

(Two causes may account for this reception; one is inductive pickup, due to close proximity of the line to the loop. The other effect is similar to one now being experienced by a number of superheterodyne owners; wherein the intermediate amplifiers oscillate at transoceanic telephone frequency, thus making audible to the listener international conversations. While Mr. Yelm does not offer sufficient information to come to any definite conclusion, we might suggest that the combination of the radio pick-up with a carrier generated in the set was necessary to create a frequency which would pass the intermediate-frequency filters.—EDITOR.)*

WAS THE SOUND REAL?

Editor, RADIO NEWS:

Here is a "mysterious" experience that an acquaintance of mine had. The day before Christmas she went to the cemetery with a wreath for her husband's grave, which has a monument at the foot and a headstone at the head. Right near the headstone is an Elk's marker. Attached to the wreath was a piece of wire with which to fasten it to the stone so that it could not be blown away. As she stooped to hang the wreath on the marker by means of the wire, she heard the strains of a band, and got up at once to look around for the source but the sound ceased as soon as she arose. My husband believes that conditions were such that when she put the wire around the stone, it formed a loop that picked up waves; these waves were reflected onto the stone, setting up vibrations that somehow brought forth music.

MRS. A. S. TRACY,
Concord, N. H.

(What changes radio waves must undergo before they can be heard is explained on page 640 in the January issue of RADIO NEWS. *The conditions present do not seem sufficient for radio reproduction. Furthermore, it is entirely possible for any person to imagine "hearing" a sound; everyone, at some time or other, "hears" something which is only imaginary, especially when under deep emotion. On the other hand, if two or more persons had heard the same sound, there could be little doubt as to its existence.*—EDITOR.)

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A TALKING MINE

In a recent edition of the *New York Evening Graphic* (January 5) appeared a feature story describing odd effects in a deserted house within half a mile of the high-powered transmitter of WEAF, at Bellmore, Long Island, a few minutes' ride out of New York City. While it was reported that the "whole house" would talk and sing, on the occasion when a committee of investigation called there was as much silence as customary when super-DX reception is to be demonstrated to visiting neighbors. However, the fact that voices and music would float around the house at times was attested, and engineers of WEAF were inclined to suspect the empty water pipes of being the means of pick-up.

The article went on to relate a story of a house in Oklahoma where radio-telegraph signals were audible some years ago (this was before the days of regular broadcasting) and were finally ascribed to the presence—even if the action could not be explained—of a large mass of copper ore found several feet below the foundations.

However, with the well-known rectifying powers of galena, has radio reception ever been noticed in or around a mine of it? Such would seem to be a place suited by nature for the purpose; but unfortunately, the radio mysteries seldom turn up where you are waiting for them with all the appliances of a research laboratory. In that respect, they are almost as unaccommodating as ghosts and other psychic phenomena.

MARITIME RADIO NOTE

Interview with C. K. Atwater in *Boys' Life* elicits the fact "that 10-meter transmission seems very good within twenty miles of the sending station. Beyond that distance the well-known SHIP

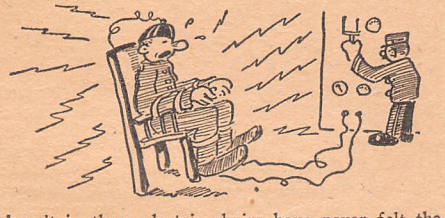
effect comes into play." This is evidently the same noted by Christopher Columbus—to-wit, that a ship disappears from sight, hull first, as she rounds the first curve in the road to the Indies.—*Raphael Levy.*

AND GOOD SELECTATION

Seventy-five cent word, which the advertising fraternity should seize upon, coined by the *Calgary* (Alberta) *Herald*: "A new radio set which . . . has a good DELECTIVITY' on any wavelength." We wish some of the artists now on the air had the same excellent quality.—*John H. Stevens.*

HANGING'S GOOD ENOUGH FOR US

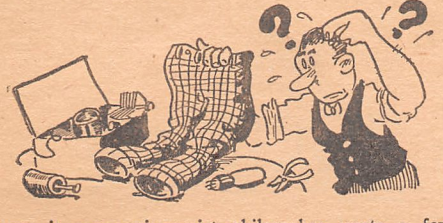
A bargain which does not appeal as it should to the wary customer appeared in the *Pittsburgh Press* as follows: "Eight-tube A.C. Electric SEAT with speaker, $85." We have heard that some people



who sit in these electric chairs have never felt the same since; and we prefer the old-fashioned Morris type.—*Andrew J. Cook.*

KNICKERS FOR A LONG HIKE

International Radio Engineers' catalog heralds a new style note by offering a "Bremer-Tully Short-Wave Kit. Contains the necessary essential PANTS for making an efficient short-wave receiver." What



was it some misogynist philosopher wrote a few months ago—that the less women have to do with radio, the better it will be? Even the sets wear trousers now.—*Francis E. Hutchinson.*

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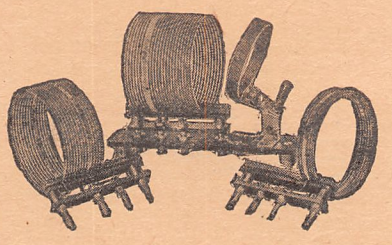

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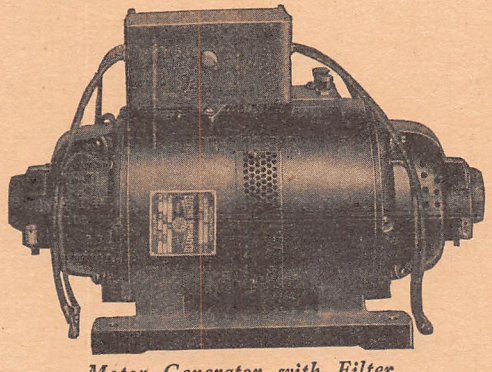

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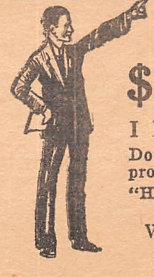

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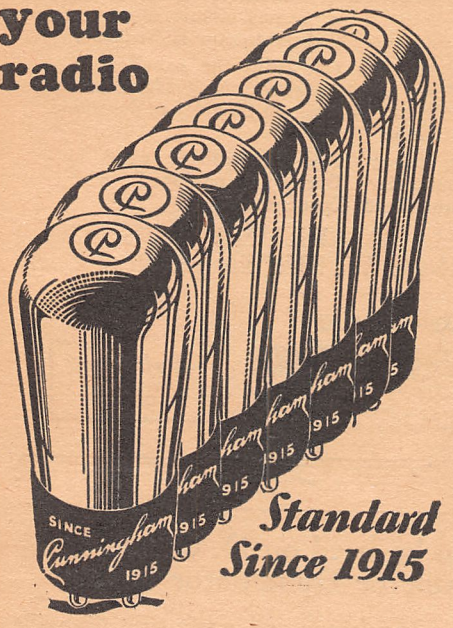

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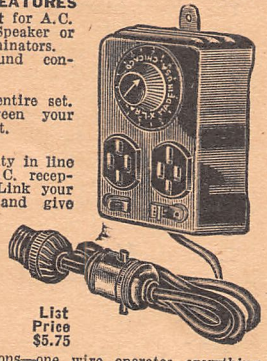

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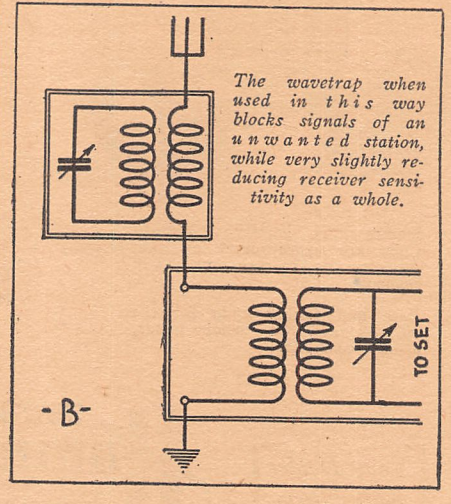
The Constructor's Own Page

(Continued from page 1023)

be attached to the aerial post of the set in use, and the other end to the primary of the coil in the unit. The secondary is tuned by a .00035-mf. condenser. The parts used are 50 feet of aerial wire,



The wavetrap when used in this way blocks signals of an unwanted station, while very slightly reducing receiver sensitivity as a whole.

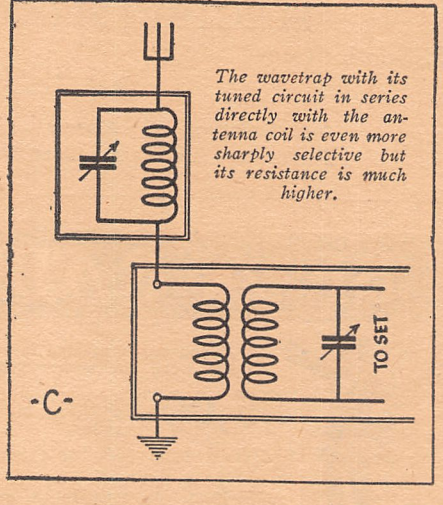
a socket, a Dresner plug-in coil, a Remler condenser and a vernier dial.

I have put these parts in a case similar to a mantel clock, which gives an attractive appearance when put on top of the radio cabinet, or alongside the same. I have demonstrated this unit to a few neighbors and they all like it so well that I had to build each of them one.

On a set using a loop, you have to experiment to find out which connection gives best results. The use of the two aerials does not broaden the receiver to which the unit is connected; but seems to affect it just the opposite way. Your opinion if the above is worth while for some manufacturer to put on he market would be appreciated.

PAUL KEULMAN,
3005 *No. Marmora Ave., Chicago, Ill.*

(This device, it will be seen, by the compact reduction of the diagram, is simply a wavetrap of the "rejector" type, coupled in parallel with the antenna coil of the set. It therefore permits the unwanted signal to leak off more readily, while maintaining the strength of the signal to which it is tuned, and therefore increases selectivity. Wavetraps in series with the antenna coil of the set, as in Figs. B and C, serve rather to tune out unwanted stations. While there are many wavetraps on the market, this may offer an excellent suggestion to custom builders whose patrons are in search of DX, and are willing to tune another circuit for the purpose. The price of increased effectiveness is increased work. A discussion of other means of increasing selectivity will be found on pages 996-7 of this issue.—EDITOR.)



The wavetrap with its tuned circuit in series directly with the antenna coil is even more sharply selective but its resistance is much higher.

THINK OF THE OTHER FELLOW

Editor, RADIO NEWS:

When the average reader of RADIO NEWS sees a new receiver described in your magazine, he may get the idea that he needs a regular laboratory to build it and is a little skittish about tackling it. But, when some other radio fan who is no better equipped builds it, he picks up a little courage and says, "So can I." Very soon there are many sets of the type described being built throughout the world, and a great many fans write the man who published his good results in RADIO NEWS. I have found, by experience, that is a very good way to increase your mail tremendously.

The majority only ask for information concerning the set, which makes a very tedious job for the man who has to answer several hundred letters of this type. Now, my idea is this: Why not enclose in the letter a self-addressed, stamped envelope and a piece of paper with questions plainly written and space to answer them beneath each question? Just think how fast letters can be answered if sent this way.

THOMAS E. MERCIER,
Fitchburg, Mass.

(We know just how our correspondent feels. We have published frequent notices to those who inquire of set builders, asking them to show this courtesy; and we offered to undertake answering letters written to us in this manner. A very small part of our daily mail was prepared in this style by inquirers, unfortunately; and it has proved necessary to abandon the plan. We would say that a set builder is under no obligation to answer any inquiries, unless they are sent to him in a manner which shows some consideration and appreciation of his generous efforts.—EDITOR.)

INQUIRIES for information not given here should be sent, not to RADIO NEWS, *but to the constructor direct—but he should NOT be asked to furnish data already published, here or elsewhere, or for instructions that an experienced builder should not need; for this is not a beginners' department. Courtesy demands that such requests should be accompanied by postage; as they are often very numerous. Reply coupons can be obtained from the postoffice for international inquiries. On the other hand, readers who solicit general correspondence must expect to bear their own share.*

This department is for free discussion to the extent that space permits; but RADIO NEWS *accepts no responsibility for the opinions of readers as to the relative merits of apparatus and circuits.*

Letters describing good results, but which do not explain the system used, are unsuited for publication; as they entail too much needless correspondence for the editors and the contributors. Give the details the first time.

A THIRD DIAPHRAGM

Editor, RADIO NEWS:

I built the "Milk-Shaker Special" with two stages of audio, and use it with a linen-diaphragm speaker which I doped with oak varnish; as I am not an artist and could not decorate it otherwise. This makes a pretty good-looking speaker. I also mounted it on small legs.

I discovered that, by extending the driving rod of the unit back of the speaker, and mounting a small paper cone on it, the volume and tone are greatly improved. The size of the cone that I used is about ten inches. I built the speaker from the diagrams in the May, 1929, issue of RADIO NEWS. I would like to hear from anyone else who is experimenting with linen-diaphragm speakers, or who have built the "Milk-Shaker Special."

OLIVER MAGEEHON,
Galt, Mo.

(Other readers who solicit correspondence are Fred Ruland, Jr., 58 Wexford St., Brighton, Mass.; Richard E. Nebel, 1104 Lincoln Place, Brooklyn, N. Y.; Elmo Griffith, Box 13, Colfax, Calif.; William Johnson, 61 Bishop St., New London, Conn.; Russell Fredd, 33 Moyallen St., Wilkes-Barre, Pa.; Camille Alberts, 103 Price Place, Akron, Ohio.—EDITOR.)

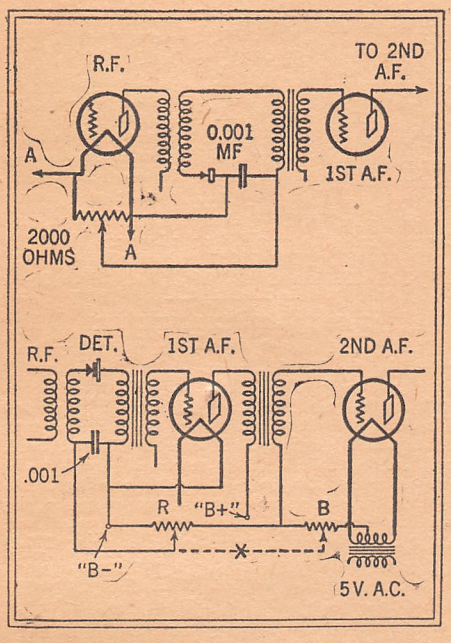
BIASING CRYSTAL DETECTORS

Editor, RADIO NEWS:

When a fixed carborundum crystal is used as the detector in an Interflex, superheterodyne or other multi-tube receiver, it is often desirable, though not essential, to increase the sensitivity by applying a biasing voltage. This voltage is generally obtained from a small flashlight cell; however, as complete electrification is becoming more and more popular, it may be desirable to find a

substitute for even the biasing battery. The diagram shows a method of accomplishing this when a series-string filament connection is used. One of the filament by-pass resistors takes the form of a potentiometer, the movable arm being connected in the detector circuit in such a way as to provide a variable voltage. If 199-type tubes are used, this will replace one of the fixed resistors; and if 201A tubes are used with a 350-milliampere rectifier, the addition of the potentiometer will produce no appreciable change in the filament current. To avoid the possibility of "motorboating" or howling, due to audio-frequency feedbacks, it is best to connect the potentiometer across one of the R.F. tubes.

If A.C. tubes are used, the biasing voltage may be obtained from a resistor inserted in the "B—"



Methods of biasing a detector crystal.

lead, as shown as R in the 2nd diagram. For use with 112-type power tubes, this should have a value of about 200 ohms, while for 171-type tubes, the resistance may be 50 or 100 ohms. By using a variable grid-bias resistor for the power tube and making the connection shown at X, R may be omitted; this may lead to trouble from feed-back, however, and the use of a separate resistor R is recommended. This will provide a bias for the crystal of about one volt, which will increase its sensitivity several times.

J. H. Arnold,
3 St. Paul St., Cambridge, Mass.

On the Short-Waves

(*Continued from page* 1027)

the sending mechanism. And after we had watched him a while we knew what the last requirement is—Patience with a capital P."

This article appraises the situation correctly. For the present, at least, high skill and endless patience are required with television, now relegated back to the short-wave channels for the attention of experimenters who do not expect too much in a hurry. Those who have the necessary requirements, like Mr. Churchill, can get a lot of fun out of the development period of television.—Editor.)

ULTRA-SHORT RADIATION AND ITS EFFECTS

With the increasing vogue of experimental radio transmission on waves of six meters and less, those of the medical profession who have been studying the possibilities of these frequencies as treatment for disease desire to sound a note of caution. Radio News is in receipt of a letter from Dr. Frank T. Woodbury, of *Physical Therapeutics* (the official organ of the American Electrotherapeutic Association) pointing out that "the electromagnetic energy of two to six meters wavelength has been shown to possess marked physiological stimulation, some of it not at all safe for human experience. What may be the ulterior effects to one continuously subjected to the proximity of a broadcast station of this frequency is problematical but, as it has not formerly occurred in nature, everyone should be on the *qui vive* for physiological changes that might become pathological. We remember the unexpected tragedies arising from the apparently harmless X-ray tubes. There is no desire to 'throw a scare' into radio enthusiasts, but only to publish a warning which it would be a dereliction of duty on our part not to do."

It will be observed that the upper limit of the band thus assigned is below the wavelengths used for any broadcasting or for any but highly experimental purposes, and this warning, therefore, does not affect the average listener, but only the *transmitting amateur or professional investigator.*

As explained in an article on page 620 of our January issue, when wavelengths are shortened to about four times the length of the human body, the latter may act as a natural aerial, reflecting radiation. This would be in the range extending from above seven down to five meters. This radiation is not felt, directly; but it was discovered that a rise in the body temperature occurs after a short period of proximity to a transmitter of ultra-high frequency.

As regards the shorter waves, while the human body is too large as a whole to serve as a resonant circuit, it may be that currents will be set up in the conductive tissues. For that reason, physicians have been experimenting with animals, and cautiously on human subjects, to determine what results may be obtained by the application of electricity internally in this manner. Cancer, for instance, is being treated in animals, but as yet the results, though encouraging, do not warrant the application to human patients.

HIGH FREQUENCIES IN THE BODY

We quote from a recent paper presented by J. Henry Hallberg to the New York Electrotherapeutic Society, and printed in the medical journal above mentioned:

"The speaker wishes to place before you the following conclusions:

"That radiant energy can and does act physiologically upon the human body in many different ways, depending upon its primary wavelength or harmonics.

"That the most minute amount of electromagnetic energy in wavelengths between three and seven-and-a-half meters can cause a human body to increase the temperature of its blood to a much greater extent than can be accounted for by heat absorption in the ordinary manner.

"That the entire human body may act as a resonator when excited by such radiation.

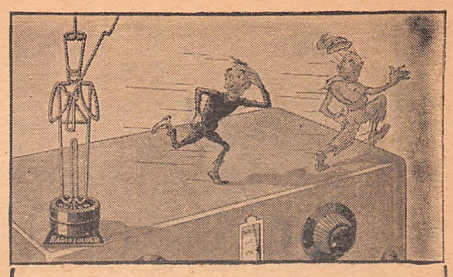
"That small groups, such as individual cells, molecules, and even atomic structures forming part of the human body, may be brought into a state of resonance to produce electronic disassociation and in that manner vary the hydrogen-ion concentration value of the blood, lymph, individual cell structures and their nuclei.

"That certain cell membranes may act as crystal rectifiers; so that, instead of going into a state of vibration, they become converters of the high-frequency energy forced through the body by means of these long waves, and in that way cause localized more or less intermittent unidirectional currents to flow, which can be reasonably conceived to produce a *direct* stimulation upon the nervous system, inducing reactions of a physical character well known to you."

And, in conclusion, we quote also this—which does not concern those who have short-wave apparatus which stays on the upper side of eight meters or so, and who are 99.944 per cent. of the radio world—from the pen of Dr. Woodbury in summing up:

"The phenomenon is being further studied by Schereschewsky at Harvard University, by Alfred E. Loomis of Loomis Laboratory, Tuxedo Park, N. J., by Robert V. Christie of the Rockefeller Institute, by Prof. Wm. T. Richards of Princeton University, by Prof. J. C. McClenahan of Toronto University, and by others. Until we learn what their findings may be, *we warn all radio broadcasters, both amateur and professional, who are using these short waves that they are using energy having decidedly powerful physiological effects, of which the entire effects are as yet unknown.* In those who are led to experiment along the lines begun by Schereschewsky, the greatest caution is indicated. From time to time a physiological audit of kidney function, heart action, blood pressure, and basal metabolism would seem indicated as a precautionary measure. It is vitally important to realize that the electromagnetic spectrum in all its parts must be treated with the greatest of respect by those investigating its properties. Others should await the result of these investigations if they would avoid unhappy results."

On the other hand, there is reason to hope that within a few years the curative powers of medicine will have been greatly increased by bringing under control these still-unfamiliar frequencies of radiation.



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Name .....

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Radio News Laboratories

(*Continued from page* 1028)

"A" type are not found on this model; as there is no necessity for them when a filter is used in this way. A .01-mf. fixed condenser of the paper type within the case constitutes the filter device.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2581.

The type "C" interference filter submitted by the same manufacturer is identical in size and appearance with type "B" described above, except for the addition of two binding posts, one of which is connected to a ground. It is designed for use in cases where additional connections are required and can be applied to all motors up to ½-horsepower.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2582.

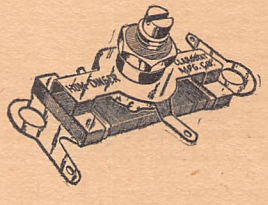
STRIP RESISTOR

The resistor strip submitted by the Clarostat Manufacturing Company of Brooklyn, New York City, and shown herewith is a wire-wound product, of fixed value, mounted on a fiber support which is threaded to hold the turns more firmly in place; thus preventing short-circuited turns and altered resistance. The fiber has rounded sides, to lessen the strain on the wire and also for neatness. The ends are firmly clamped to give positive contact and mechanical strength, and have mounting holes as well as soldering tabs. It measures 2 x ½ inches. The resistance value stamped on one end is maintained to within 10 per cent. They are available in any resistance value from one to 3000 ohms, and are furnished in adjustable models, if preferred.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2585.

A.C. TUBE RESISTOR

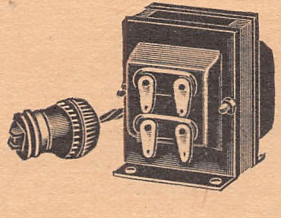
An adjustable center-tapped resistor of extreme compactness is provided in the "Hum-dinger" type marketed by the same manufacturer, and illustrated herewith. Over the center portion of the winding slides a positive contact, actuated by a slotted shaft which is turned by a screwdriver or similar instrument. It may be mounted on a panel or sub-panel, through a single hole, or on the baseboard by wood screws slipped through holes in the end lugs. Connections are made to three soldering tabs. The wire winding is held by a threaded fiber support, so that the turns cannot slip and short-circuit. The contact arm is protected from bending. The standard resistance value for the usual A.C. circuit is 30 ohms; but other values from 6 to 500 ohms are available. The device measures 2 x ⅝ inches.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2584.

FILAMENT TRANSFORMER

A new product in the transformer field, submitted by the Thordarson Electric Manufacturing Company, Chicago, Illinois, is known as "Type 3081." It is furnished with two secondary windings; one supplies 2½ volts for the operation of two 227-type tubes, and the other 1½ volts for two 226-type tubes. The component measures 3¼ x 3 x 2½ inches, and is supplied with a six-foot lamp cord terminating with a plug and a screw receptacle. Soldering lugs are included for connections and the construction is of the semi-shielded type.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2590.

INTERFERENCE FILTER

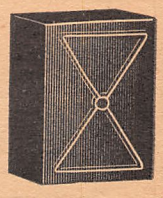
Submitted by the Tobe Deutschmann Company of Canton, Massachusetts, the "Junior" model of this manufacturer's line of "Filterettes" is illustrated here. The device is designed so that it may

be connected to the offending electrical appliance without wiring. Its bakelite housing measures 2½ inches long and 1½ inches in diameter, and contains two fixed condensers wired in series, with their common terminal brought out to a binding post so that it may be grounded. One end of the device has a built-in receptacle for the appliance plug; the other end takes the form of a plug for the house-line receptacle.

AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2588.

STAGE SHIELD

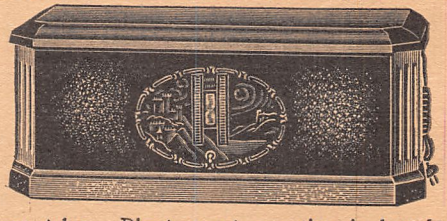
The "Type 638" stage shield, submitted by Silver-Marshall, Inc., Chicago, Illinois, is a convenient item for constructors desiring compactness in a radio receiver. This particular model measures 5⅝ x 4½ x 2⅝ inches, is constructed of lacquered copper and is removable from the top and bottom. The bottom plate is drilled to facilitate the mounting of apparatus. In the hands of an ingenious constructor, a shield can of this type could make a convenient and efficient container for a short-wave receiver or adapter.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2589.

D.C. ELECTRIC RECEIVER

The "Model 80" D.C. broadcast receiver submitted by the Freed-Eiseman Radio Corporation of Brooklyn, New York City, and illustrated herewith is designed for complete lamp-socket operation from a direct-current source only, and as such functions satisfactorily. It comprises seven tubes employed as follows: four stages of tuned radio-frequency amplification and a detector using 201A-type tubes, one stage of transformer-coupled audio amplification using a 171A-type amplifier and one stage of push-pull amplification, also using 171A-type tubes. Direct-current operation is brought about economically by series-filament operation. The receiver is mounted in a handsome metal cabinet 20 x 11 x 8½ inches, and finished in dark bronze. A bronze escutcheon mounts the volume control, which comprises a tapered potentiometer connected across the aerial and ground, a drum control for the four-gang condenser, and a snap switch for current-input control.



AWARDED THE RADIO NEWS LABORATORIES CERTIFICATE OF MERIT NO. 2591.

Radio Book Review

By H. M. BAYER

ADVERTISING BY RADIO, by Orrin E. Dunlap, Jr. Published by The Ronald Press, New York City. 8¾x6 inches, 186 pages. Price $4.00.

Mr. Dunlap, for some years radio editor of the *New York Times*, and not unknown to readers of RADIO NEWS, has written an excellently worded "bible" for the sponsor-to-be of commercial broadcasting, in which the prospective advertiser is taken aside for a fatherly talking to. And, if we must say so, the author has hit the microphone on its carbon-button in every one of his stated facts except one assertion, perhaps, which we believe to be a matter of purely personal opinion.

Mr. Dunlap states that broadcasting recorded music is poor policy for the "air" advertiser, and is liable to incur the displeasure of listeners. To strengthen his belief he offers the following: "Judge Ira E. Robinson, as chairman of the Federal Radio Commission, came out openly against broadcasting of phonograph records, and several commissioners have privately expressed themselves adversely. So nearly do the electrically-reproduced phonograph records sound like the real thing that Judge Robinson admitted that he had been fooled by them, and was unaware that a record was being radiated until the announcer revealed the fact. *(In other words, the judge had been enjoying the music until the announcement that it was a record and, then, dis-*

covered suddenly that he had not been enjoying it! —REVIEWER.) He said that he was not prejudiced against phonograph records, but that it was his impression that listeners as a body are opposed to this type of entertainment because it can be obtained at home without broadcasting."

To employ the age-worn breath-catcher, we might say, "Now that depends—." Were we to listen to a fair choice of radiated records featuring popular numbers, and emanating from a station boasting a fair quality of modulation, we are frank to admit that it would sound just as well to us and be just as welcome as an original program offered before the microphone by the makers of the records. And if we, as well as the good judge, may indulge in a bit of generalizing, we are quite sure that the average listener would much rather listen to a program of "canned" music rather than take the trouble to play the same records on his talking-machine. We well remember when, back in the early days of broadcasting, the radio salesman was first forced to employ a now familiar sales-"line." This is one of the many variations: "Yes, sir, your phonograph may give you what you want *when* you want it; but think of the luxury of being able to relax in your easy-chair all evening without getting up once to change the record, wind the motor, or jab needles into your thumb."

Hear the same thing at home without broadcasting? The listener is invited to keep a check on the number of times he hears: "You're the Cream in My Coffee," "Sonny Boy" and the like, in one evening, rendered by "original" orchestras, which, in many cases, cannot equal the performance selected for recording. The early records of Moran and Mack caused and, for that matter, are still causing more laughter than the recent "original" broadcasting of these worthies who have, perhaps, gone slightly stale. Furthermore, we see no reason why a well-made record of an aria, broadcast from a well-engineered station, should not entertain equally as well as the "original"—a term here used to mean a repetition.

In conclusion, we might add that whereas, in the case of mechanical music, records are made only by the finest talent in the musical world, the same, unfortunately, cannot be said for the average original program which finds its way into the air these days. If it is a choice between well-played selections from records, and intolerable wailings from "originals," there is hardly any necessity of calling upon Mr. Hobson for consultation. It may be commented, as well, that throughout the world —in Europe, Asia and elsewhere, where listeners are no less critical of musical quality—reproduced records make up no small part of the programs of even large stations.

However, everything else said by Mr. Dunlap, the reviewer will agree, might well be committed to memory by every radio advertiser, and recited aloud by him every time he signs a contract for toll-time on a broadcast station.

FROM CRYSTAL TO TELEVISION, by Vyvyan Richards. Published by the MacMillan Company, New York City. 7¾x 5½ inches; 116 pages; line drawings.

Mr. (or Miss?) Richards undertakes an heroic feat but it may be queried if the effort can be said to serve its purpose. In defence of the author and his (our conclusion is final) work, it should be said that all similar attempts to enlighten the layman by means of so-called "elements for the beginner" have failed to attain their goal; for the simple reason that there is no such thing possible as simple explanation for the layman in any engineering subject. Plain, non-technical English may serve to inform a tyro that the aerial picks up radiated energy and feeds it into the receiver; or one may point out to the beginner that this or that tube amplifies the signal, so that it will actuate a loud speaker. But, when an author attempts to enter the realms of the electronic theory, magnetic action and television, a halt should be called; a subject is either studied or glanced over. The man who operates his own car is by no means an "automotive engineer," nor can the dial-twister acquire without highly-mathematical studies any fundamental understanding of radio engineering.

A foreword by John L. Baird, Great Britain's favorite son in the great television race, offers this explanation, to which the **reviewer** consents:

"Mr. Richards," says Mr. Baird, "in this little book explains in a remarkable and very readable manner the nature and behavior of these electrons, and the part they play in wireless and other electrical phenomena. He carefully avoids anything in the nature of mathematical formulae, and has presented the subject in such a way that it cannot but be interesting, particularly to those who do not wish (or have not the time) to go deeply into the subject, but are anxious to obtain a grasp of the fundamental principles."

I Want to Know

(*Continued from page* 1030)

flow of a current *inside* a battery or source of power. *Outside* the battery, however, the actual flow of electrons (supposing that there are such things as electrons) is from negative to positive; so for instance, the electrons flow from the heated filament or cathode of a vacuum tube to the "anode" or plate.

In figuring how to obtain the "C" bias required on an amplifier (when the voltage drop in resistors is employed to give this bias) it is necessary to consider several points. If the grid potential is obtained from the "B" power unit, as shown in Fig. Q-2340A, the total plate current, multiplied by the amount of resistance between the "B—" terminal and the "C—" tap determines the bias. This tap may be used for several tubes if desired, provided the bias for each of them is the same. If a different bias is desired on each tube, it is necessary to provide additional taps.

If, on the other hand, the bias is obtained as shown in Fig. Q-2340B, it is determined by the plate current of each tube; and the proper resistance value also depends on this current. The "C" bias is obtained between the filament circuit and the grid circuit and, by using the correct value of resistance, although the grid circuits are connected together, the filament circuits are placed at different potentials, which provides the necessary voltage drop. This method is shown in Fig. Q-2340B.

The value of the resistance (required to give a certain bias) is determined through dividing that voltage by the plate current of the tube or tubes connected to that filament circuit; the latter two values may be obtained from the instruction sheet enclosed with each tube. For example, we find that the 171A tube requires 40 volts grid bias when 180 volts is applied to the plate; the current is 20 milliamperes or .02-ampere. The result obtained when 40 is divided by .02 is 2000, the resistance in ohms required. In like manner, we find the 227 tube is supplied with a 9-volt bias, through an 1800-ohm resistor.

COIL-WINDING INFORMATION

(2341) Mr. M. Galante, Brooklyn, N. Y., writes:

(Q.) "I would be obliged to you if you could tell me how many turns to place on a 2-inch tube for the primary and secondary, using litz wire (equivalent to No. 25 B. & S. gauge, containing 20 strands of number 38 wire) when a 199 tube is to be used with a .00035-mf. condenser.

"Also please give me the constants for No. 22 D.S.C. wire for the same tubes and tubing. I've walked all over New York City and can't find coils for the 199s, as they don't make them any more."

(A.1) A coil to be incorporated in a set using 199-type tubes, and covering the broadcast band, may be wound with a secondary of 98 turns of the litz wire you describe, on a 2-inch tube. The primary size depends on the type of stabilizing and the type of circuit in which the coil is to be used. If a "losser" control is used, such as a resistor in the plate lead, the primary should contain about 15 turns or in some cases, more. In sets of the neutrodyne or similar types, a primary of about 20 turns may be used safely, without making the set unstable. If a *tapped* primary is used for neutralizing, the complete primary should contain 40 turns with a tap at the 20th turn.

In the aerial circuit, it may be advisable to use a somewhat smaller primary in order to make the set sufficiently selective.

(A.2) If No. 22 double-silk-covered wire is used in place of the litz wire, the secondary should contain 108 turns. The primary is wound according to the instructions given above and depends on the type of balancing used.

(A.3) Tuned radio-frequency coils designed for the 201A-type tubes are quite satisfactory for the 199s in most cases. The 201As oscillate more easily than the smaller tubes and, if losser methods of oscillation control are used, the efficiency of the amplifier might be poor when using the 199s. However, if the primary is increased slightly in size, this trouble will be overcome.

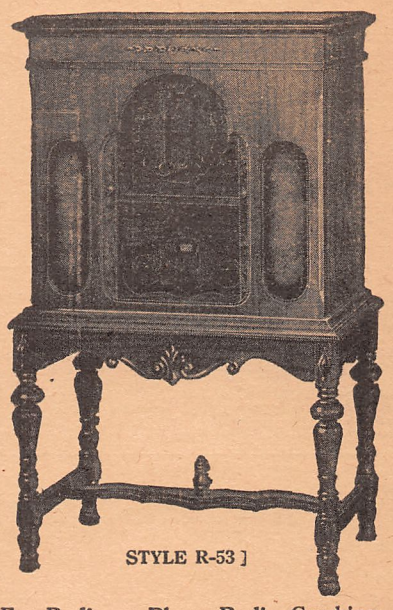
If the set is a neutrodyne or uses a similar method of oscillation control, no changes are necessary; the same coils will be quite suitable.

"TRANSMISSION UNIT"

(2342) Mr. B. D. Thuma, Ann Arbor, Michigan, writes:

"Will you be so kind as to answer the following questions for me:

PHONO Radio Consoles



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For Radio or Phono-Radio Combination. A beautiful Walnut Cabinet with sliding doors of matched Butt Walnut. Ample space for Receiver, Speaker, and Phonograph equipment.

A descriptive bulletin of new 1929 styles sent free on request.

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DRESNER Shielded SHORT WAVE CONVERTER

16.50 Complete with 5 COILS

The Only Set with a Wave-length Range 15 to 550 Meters

First time offered! New 1929 model—completely assembled; can be used on any set; built in beautiful mahogany finished metal cabinet. Highest efficiency at amazingly low price. Gets programs broadcast on short waves by many powerful stations throughout America and Europe.

If your dealer cannot supply you, send money order direct and we will ship at once. Guaranteed. (When ordering unit, be sure to specify whether it is to be used on AC or DC set.)

DRESNER RADIO MANUFACTURING CORP.
640 Southern Blvd., Dept. R-5, New York, N. Y.

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BARAWIK CO. 25H Canal Sta., CHICAGO, U. S. A.

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Objectionable or misleading advertisements not accepted. Advertisements for the July issue must reach us not later than May 2nd.

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$50.00 Weekly. Men wanted to demonstrate and take ten orders daily direct from motorists. Amazing Magnetic Trouble Light. Sticks anywhere! More orders, bigger pay. Write for demonstrator and particulars. Magno, Beacon Bldg., Dept. 795, Boston, Mass.

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Amateur Cartoonists: Sell Your Cartoons New Plan. Smith's Service EX1194, Wenatchee, Wash.

Free Book. Start little Mail Order business. Hadwil, 5A-74 Cortlandt Street, N. Y.

Inventors: Write for Free Booklet "Suggestions from Manufacturers on What to Invent.' Adam Fisher Mfg. Co., 278 Enright, St. Louis, Mo.

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Used correspondence school courses sold on repurchase basis. Also rented and exchanged. Money-back guarantee. Catalog free. (Courses bought). Lee Mountain, Pisgah, Alabama.

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Detectives Needed Everywhere. Travel. Experience unnecessary. Particulars Free. Write, American Detective System, 2190 Broadway, N. Y.

For Inventors

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Forms to Cast Lead Soldiers, Indians, Marines, Trappers, Animals, 151 kinds. Send 10c for illustrated Catalogue. H. C. Schiercke, 1034 72nd St., Brooklyn, N. Y.

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$2 to $500 each paid for hundreds of Old or Odd Coins. Keep all old money, it may be very valuable. Send 10c. for New Illustrated Coin Value Book 4x6. Guaranteed prices. Get posted. We pay Cash. Clarke Coin Company, 14 Street, LeRoy, N. Y.

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Who knows but that the opportunity of your lifetime may be hidden in one of them. Read them each month—they can easily be turned to earning dollars and cents for you.

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Patents—Time counts in applying for patents. Don't risk delay in protecting your ideas. Send sketch of model for instructions or write for free book, "How to Obtain a Patent" and "Record of Invention" form. No charge for information on how to proceed. Communications strictly confidential. Prompt, careful, efficient service. Clarence A. O'Brien, Registered Patent Attorney, 309 Security Bank Building (directly across street from Patent Office), Washington, D. C.

Patents—Write for Free Instructions. Send Drawing or Model for Examination. Carl Miller, Registered Patent Attorney (former Patent Office Examiner), 262 McGill Building, Washington, D. C.

Patents—Send for form "Evidence of Conception" to be signed and witnessed. Form, fee schedule, information free. Lancaster and Allwine, Registered Patent Attorneys in United States and Canada, 269 Ouray Bldg., Washington, D. C.

Inventors—Should write for our Guide Book, "How to Obtain a Patent," and Record of Invention Blank, sent Free. Send model or sketch of inventions for our inspection and instructions free. Radio, Electrical, Chemical, Mechanical and Trademark Experts. Terms Reasonable. Victor J. Evans & Co., 922 Ninth, Washington, D. C.

Patents—Send drawing or model of your invention for examination and instructions. Advice and booklet free. Highest references. Best results. Promptness assured. Watson E. Coleman, Patent Lawyer, 724 9th Street, N.W., Washington, D. C.

Patents

Inventors: Write for Free Booklet "Suggestions from Manufacturers on What to Invent." Adam Fisher Mfg. Co., 278 Enright, St. Louis, Mo.

Printing, Engraving and Multigraphing

Multigraphing, two dollars thousand. Miscellaneous Printing. Mayera Corporation, Monmouth, Illinois.

Your Own Correspondence Stationery. Name and address on 125 DeLuxe lettersheets and 125 envelopes $2.20 postpaid. Oberman Company, Box 1042, Chicago.

Printing Outfits and Supplies

Print Your Own Cards, Stationery, Circulars, Advertising, etc. Complete outfits, $8.85; Job Presses, $11, $29; Rotary, $149. Print for others; big profit. Easy rules furnished. Write for Catalog Presses, Type, Paper, etc. Kelsey Company, J-13, Meriden, Conn.

Radio

Bargains, used radios. Guaranteed perfect working order. Blue Ribbon 5 tube, 2 dial, Console, $19.95. Freshman, $14.95. Atwater Kent, $19.50. Many famous makes. Send money order with order. Bargain list on request. Surplus Radio Co., Dept. 2-E, 4611 N. Clark St., Chicago.

Wanted: Men to work with National Radio Service organization. No selling scheme. Radio Doctors, Inc., Dept. N. Essex St., Salem, Mass.

We Rebuild Audio Transformers, any kind, $1. We rewind them to give clearer tone and greater volume than when new. Satisfaction guaranteed. Lininger Radio, 1157 E. 113th St., Cleveland, O.

Build Your Dynamic Speaker. Machines castings, blueprint, instructions, $8.50. A. C. Klein Co., 1058 N. 10th, Reading, Penna.

Bargains—1 Stewart Warner Electric $65.00, 3 Crosley Showboxes $75.00 each, 1 Crosley Gembox $50.00. All sets complete with tubes and speaker. Carlisle Benjamin, Clyde, N. Y.

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Big Ohio Corporation wants county manager. $50 weekly commission. Earnings start immediately. Good for $5,000 yearly. We furnish everything, deliver and collect. Capital or experience unnecessary. Fyr-Fyter Co., 1880 Fyr-Fyter Bldg., Dayton, Ohio.

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Song Poem Writers: "Real" Proposition. Hibbeler, D7X, 2104N. Keystone, Chicago.

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Telegraphy—Both Morse and Wireless taught thoroughly. Big salaries. Wonderful opportunities. Expenses low, chance to earn part. School established fifty years. Catalog free. Dodge's Institute, Cour St., Valparaiso, Ind.

(Q.1) "Define 'transmission unit.'

(Q.2) "'In rating the plate impedance of a tube, what frequency is used as standard?

(Q.3) "Is there on the market at the present time a moving-coil speaker unit designed to be used with a horn?"

(A.1) The popularity of the dynamic cone speakers has introduced a new term to many radio enthusiasts and it has caused a large amount of confusion in the minds of many of them, due to the lack of definition for this new term.

The *transmission unit* is a standard for measuring the gain or amplification in audio amplifiers, the gain or loss in any A.F. circuit or transmission apparatus, and finally for the comparison of output signal strength in two receivers or circuits. One of the uses of this unit is to measure the efficiency of speakers, and it has been introduced to the public by the literature describing the electrodynamic speaker, as we have said. The transmission unit, however, has been in use by telephone engineers for many years.

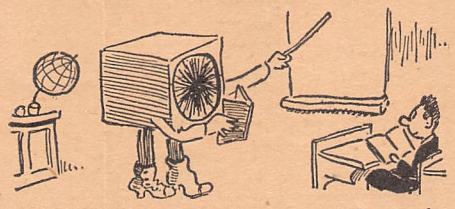
To give an explanation of the purpose of the unit, it must be pointed out that the response of the ear to change of intensity in sounds differs from that of electrical apparatus. (The article, "How Much Amplification for the Best Quality?" in RADIO NEWS for September, 1928, deals with this subject at some length.) If the input current and the output current of an amplifier are measured electrically, say in milliwatts, their quotient is the "power ratio." If, however, we step up the power ratio 150 times, the ear detects an increase in loudness of the output only in the ratio of about one to five. That is to say, its response indicates only an *arithmetical* progression of loudness while the power rate is increasing *geometrically*. The transmission units correspond to our judgment of the loudness of sounds obtained through the sensation of hearing; they are measured in multiples of the *logarithms* of the power ratio. This explanation cannot be made more clear for readers not acquainted with this branch of mathematics; but tables of corresponding power ratios and transmission units may be found in a number of text books and may be compared.

(A.2) The tables of vacuum-tube characteristics give the plate impedance, as a rule, without specifying the frequency at which it is measured. However, at a given plate voltage, etc., this impedance varies but little over the audible band; if it did, tube distortion would be most serious. As a general rule, 1,000 cycles is used in laboratory work; though 60 cycles may be conveniently used, as this current is readily obtainable.

(A.3) We have not seen any speakers equipped with moving-coil diaphragms for the ordinary exponential horns now on the market. A model on the market some years ago used such a unit with a straight horn of the old-fashioned type, and many of our readers have converted them into free-edge cone speakers. However, there is now manufactured a large horn, with a comparatively short air column, but large bell, which fits over a dynamic cone speaker unit and concentrates its output directionally. It also takes the place of a conventional baffle. Because of the large size of the moving cone, the throat of this horn is large to receive it, instead of the small diaphragm in use with most "exponential horns" sold with magnetic units. This materially shortens the length of the horn, which, however, follows an exponential curve.

OUR UNDERVALUED EDUCATORS

Educational note from the *Detroit News* informs us that "Jewett WJR console speakers, sweet and clear tone, $3.25 TEACH while they last." Every



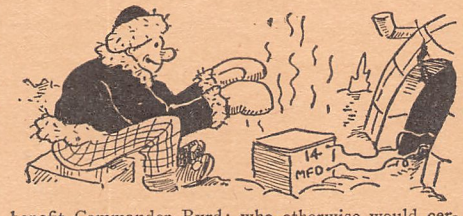
one knows that teaching is a very trying profession, and it is only too probable that these sweet young speakers will shortly become old-maidenish, prosy and uninteresting.—*Wm. G. Mortimer.*

WE'RE WAITING FOR THE SOCKETS

Service to prospective set owners offered by the Uptown Radio Sales of Indianapolis, according to the *Daily Newss* "We make SERIAL installation; give us a call." A dial down, and the rest when you can catch 'em.—*Francis J. Lahmann.*

CANCEL THAT ORDER FOR COAL

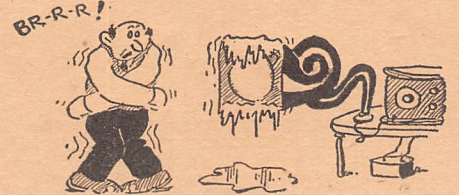
The offer of a "SELF-HEATING 14 mfd. Block U. S. Condenser" in the *New York Sun* of December 1 came, unfortunately, just too late to



benefit Commander Byrd; who otherwise would certainly have laid in a stock of these comforts for his quarters at the Bay of Whales.—*R. Madill.*

AND WE WON'T NEED ICE TODAY

While, on the other hand, this description of an exponential horn from the *Western Radio Co.'s* catalog:—"FROST area 19x24 in.; depth 12½ in.,



air column 136 in."—suggests a very popular combination for tropical radio sets and refrigerators. But could it reproduce "Red Hot Mamma," we ask you?—*G. R. Fletcher.*

AND SPOT CASH, TOO

We know that our worthy hamtemporary, *QST*, is ever vigilant for the rights of all good relaytricians; and we are therefore surprised to note that

the October issue offers "G. E. HOTWIRE AMATEUR 0-2.5—$3." Any good livewire "ham" should be worth several times that sum, any day. —*G. Farr.*

AMAZING STORIES

In Our May Issue:

The Diabolical Drug, by Clare Winger Harris. The preservation and lengthening of life is used as a basis for this engrossing story, which shows a very astonishing possible psychological effect of a drug of that kind.

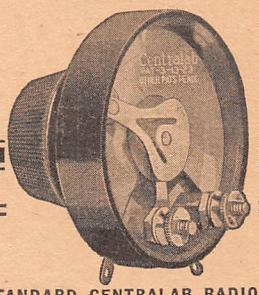
The English at the North Pole, by Jules Verne (Part I). This story, and its sequel, tell much about the polar regions, the formation of icebergs, and the movements of the ice. But, in his own inimitable style, Verne never forgets to make his story more absorbing by weaving into it adventure, hardship and human interest.

The Gas-Weed, by Stanton A. Coblentz. This story, by the author of "The Sunken World," depicts a strange invasion of the United States, where the attack spreads so that it threatens the world. It is unusually rich in its scientific interest, and also excellent as a bit of fiction.

The Moon Strollers, by J. Rogers Ullrich. Here is one of the best moon stories which we have seen in a long time, and in it are explained the latest scientific discoveries. It shows how explorers would get about on our satellite, which has practically no air, and whose temperature at all times is very near absolute zero.

And others.

Volume Controls Electrically-Mechanically Smooth



STANDARD CENTRALAB RADIOHM
0 - 2,000 ohms to
0 - 500,000 ohms
$2.00

Mechanical and electrical construction to conform to present-day high standards is a most important factor in insuring excellence in performance.

Centralab volume controls by virtue of the exclusive rocking-disc contact insure long life and quiet, smooth performance so essential in tempering radio reception to the exact tone desired.

The rocking-disc eliminates wear on the resistance material, allowing this important controlling element to remain constant at all times. This constancy of resistance is the determining factor of smooth and gradual control and insures a gradation of intensity from a whisper to maximum.

Fundamental circuits with recommended resistance tapers for smooth volume control are contained in a booklet, "Volume Controls and Voltage Controls—Their Use"—Write for it.

Central Radio Laboratories

Centralab

20 Keefe Avenue Milwaukee, Wis.

TUNE IN ON THE SHORT WAVES

The reception of foreign broadcasting is only practical on the short waves. No foreign broadcasting can be received on the broadcast band, except in some very favorable locations.

SHORT WAVES ARE POPULAR

and you may get just as good results with a "Submariner" attached to your present set, as with any short wave receiver.

THE SUBMARINER

is the original and pioneer short wave adapter. It has been nationally advertised and sold in all parts of the world since June, 1926. Naturally, it has all the latest radio improvements. IT IS MANUFACTURED COMPLETELY SHIELDED AND HAS BEEN FOR OVER A YEAR. IT HAS A TUNING DIAL WITH A RATIO OF 32 TO 1. THIS ALONE MAKES IT FAR AHEAD OF ANY SHORT WAVE RECEIVING EQUIPMENT. It is a quality product that is appreciated by even the most experienced operators.

FOUR MODELS

20 to 65 meters for battery tubes, $15.00. For all electric, $17.50. Interchangeable coil model, 10 to 160 meters, $22.50, for A.C. or D.C. receiver. No. 4 coil, 160 to 340 meters, $2.00 additional. In ordering, be sure and state name of set and the number on each tube. Ask your dealer for one. If he does not carry them, he will get one for you.

If you are unable to get one locally, it will be sent postpaid upon receipt of money order or certified check. Sent C.O.D. only if $1.00 accompanies order. This is to insure carrying charges. Price in Canada and some other foreign countries, 60c. additional. Cannot be sent C.O.D. outside U. S.

ORDER TO-DAY

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3411 Fond du Lac Ave. Milwaukee, Wis., U. S. A.

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7 TUBE SUPERPHONIC RADIO $16.95

An amazing value that can't be beat! Latest 7 tube tuned radio frequency circuit. Send for complete descriptive circular.

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4611 N. Clark St., Dept. 12-E, Chicago

Announcing

TRIAD
RADIO TUBES

THE tube perfection for which the radio world has waited, has at last been achieved—in Triad Radio Tubes! An organization of scientists and engineers thoroughly versed in the manufacture of quality radio tubes is responsible for this remarkable development. Their reputation, experience and knowledge, constitute a dependable assurance of radio tube quality which has never been known before. Your dealer will gladly point out to you the superior features which only Triad Tubes offer.

QUALITY — SERVICE — DURABILITY

TRIAD MFG. COMPANY, INC.

GEORGE COBY, *President* ELY EGNATOFF, *Treasurer*
HARRY H. STEINLE, *Vice-Pres. and Gen. Sales Mgr.*
WILLIAM CEPEK, *Secretary*

PAWTUCKET, R. I.

"Ask for the tube in the triangular box"

Please say you saw it in RADIO NEWS

The Only Service Instrument That Will Make All These Tests

It has the only tube tester giving oscillation tests from raw A.C., or from radio sockets. Tests all tubes 1½ to 15 volts, including screen grid and heater types. Reads direct output of rectifier tubes. Permits complete and comprehensive analyzing from radio socket of all type A.C. or D.C. radios with Master plunger selector system. Voltage readings with and without load. Gives independent cathode readings.

The modulated tube radiator takes place of broadcast stations for testing—is a driver for neutralizing and oscillator for synchronizing, giving meter dip and speaker click at resonance. Has heavy duty rejuvenator. Bridges open stages of audio—alters outputs—tests

fixed condensers and contains stage of audio—fixed capacities—500,000 ohm variable resistance and 30 ohm rheostat.

Besides regular tests, all apparatus is accessible through pin jacks. Instrument lifts out of case.

Absolute Accuracy Assured

Three Weston meters and SUPREME engineering, combined with the finest of materials and workmanship, insure absolute accuracy. A Voltmeter of three scales, 0-10-100-600, 1,000 ohms per volt; a Milammeter of 125 mils and 2½ amps; and an A.C. Voltmeter, three large scales of 0-3-15-150, are built into the SUPREME test panel and are housed in Bakelite cases.

All instruments are manufactured for 110 volts and 50-60 cycles. Instruments of other frequencies can be furnished special at slight increase in price.

World's Leading Radio Engineers Praise the Supreme Diagnometer

THE SUPREME Diagnometer is recognized as the outstanding. service instrument in radio. In one gigantic forward stride, this marvelous instrument changed the standards of radio service. It filled the long-felt need of radiotricians for a single, compact, portable instrument that would not only make all tests upon which they had previously been forced to rely, but would also provide those necessary tests and analyses which had previously been restricted to the most complete and expensively equipped radio laboratories.

A Real Profit Maker

With the Supreme Diagnometer the radiotrician is mechanically equipped to solve any radio problem that may come before him. He is prepared to handle intricate and technical tasks in a way that will earn the enthusiastic satisfaction of his patrons and enable him to command the highest fees.

Yet the SUPREME is amazingly simple to understand and operate. Its compact portable carrying case weighs only 25 pounds and measures 18 x 10½ x 7 inches. The case is ingenious and convenient in design, providing handy compartments for carrying all necessary tools, adapters, and accessories, including a swinging tube shelf which affords complete protection to extra tubes.

SUPREME Service League members everywhere are securing greater increases in business and earnings. Those who sell radios report that the reputation they have gained for dependable and scientific service has increased their receiver sales as well as their service profits. Radio owners have learned and are telling each other that SUPREME Service is the most dependable and thorough to be had.

Order a SUPREME Diagnometer on our six-day trial plan. See for yourself what this amazing instrument will do for you.

Look for the Sign of Efficient Radio Service

Radio Owners: Look for this emblem in your radio shop or on the button worn or card carried by your service man. *It is your guarantee of dependable service.*

Send No Money

Thousands of owners attest to the superiority of the SUPREME. PROVE its value to you by using it six days in actual service work. We let you be the sole judge. Sign and fill in the six-day trial request and mail today.

Prices and Terms

Under our time payment plan, the Model 400A SUPREME Diagnometer can be bought for $38.50 cash and 10 trade acceptances (installment notes) for $10.00 each, due monthly. Cash price, if preferred, $124.65. All prices net; no dealers' discounts.

6-Day Trial

Date.....

Supreme Instruments Corporation,
323 Supreme Building,
Greenwood, Miss.

Please ship me one Model 400A SUPREME Diagnometer.

Upon delivery of the instrument, I will deposit with the express agent either the cash price of $124.65 or $38.50 cash and 10 trade acceptances (installment notes) for $10.00 each, due monthly, at my option, subject to the following conditions:

It is agreed that the deposit made with the express agent shall be retained by him for six days. If, within that time, after testing the instrument, I am not entirely satisfied, I have the privilege of returning the instrument to the express agent in good condition, with the seal unbroken (see note below) and adapters and parts intact. Upon such return, and upon the prepayment of return express charges, the deposit I have made with the express agent will be promptly returned to me.

Signed .....

Firm Name .....

Address .....

City..... State.....

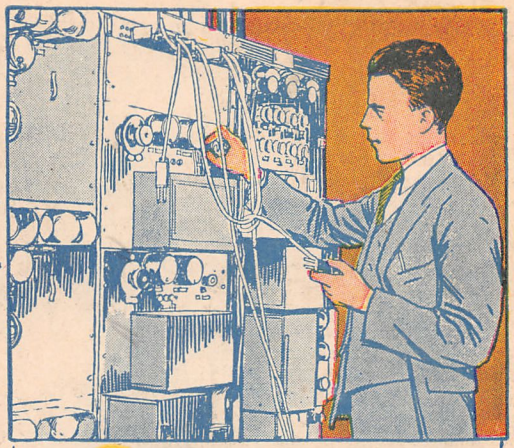
Please send three or more trade references, including at least one bank, with this coupon.

NOTE: The seal on the panel of the instrument covers the master screw in the assembly. It is never necessary to disturb this, and it does not in any way prevent or restrict the use of the instrument. Factory guarantee ceases with disturbance of seal.

SUPREME
Radio Diagnometer

Makes every conceivable test on any Radio Set—

I Will Train You at Home to Fill a Big-Pay Radio Job



If you are earning a penny less than $50 a week, send for my book of information on the opportunities in Radio. It's FREE. Clip the coupon NOW. A flood of gold is pouring into Radio creating hundreds of big pay jobs. Why go along at $25, $30 or $45 a week when the good jobs in Radio pay $50, $75 and up to $250 a week? "Rich Rewards in Radio" gives full information on these big jobs and explains how you can quickly learn Radio through my easy, practical home-study training.

Salaries of $50 to $250 a Week Not Unusual

The amazing growth of Radio has astounded the world. In a few short years three hundred thousand jobs have been created. And the biggest growth is still to come. That's why salaries of $50 to $250 a week are not unusual. Radio simply hasn't got nearly the number of thoroughly trained men it needs.

You Can Learn Quickly and Easily in Spare Time

Hundreds of N. R. I. trained men are today making big money—holding down big jobs—in the Radio field. You, too, should get into Radio. You can stay home, hold your job, and learn in your spare time. Lack of high school education or Radio experience are no drawbacks.

Many Earn $15, $20, $30 Weekly on the Side While Learning

I teach you to begin making money shortly after you enroll. My new practical method makes this possible. I give you SIX BIG OUTFITS of Radio parts and teach you to build practically every type of receiving set known. M. E. Sullivan, 412 73rd St., Brooklyn, N. Y., writes, "I made $720 while studying." G. W. Page, 1807 21st Ave., S. Nashville, Tenn. "I picked up $935 in my spare time while studying."

Your Money Back If Not Satisfied

My course fits you for all lines—manufactruing, selling, servicing sets, in business for yourself, operating on board ship or in a broadcasting station—and many others. I back up my training with a signed agreement to refund every penny of your money if after completion you are not satisfied with the lessons and instructions I give you.

Act NOW—64-Page Book is FREE

Send for this big book of Radio information. It has put hundreds of fellows on the road to bigger pay and success. Get it. See what Radio offers you, and how my Employment Department helps you get into Radio after you graduate. Clip or tear out the coupon and mail it RIGHT NOW.

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National Radio Institute,
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RADIO NEEDS TRAINED MEN!

Here's the PROOF

$375 in One Month's Spare Time

"Recently I made $375 in one month in my spare time installing, servicing, selling Radio sets. I have earned enough in one week to pay for my course."
Earle Cummings,
18 Webster St.,
Haverhill, Mass.

$500 a Month

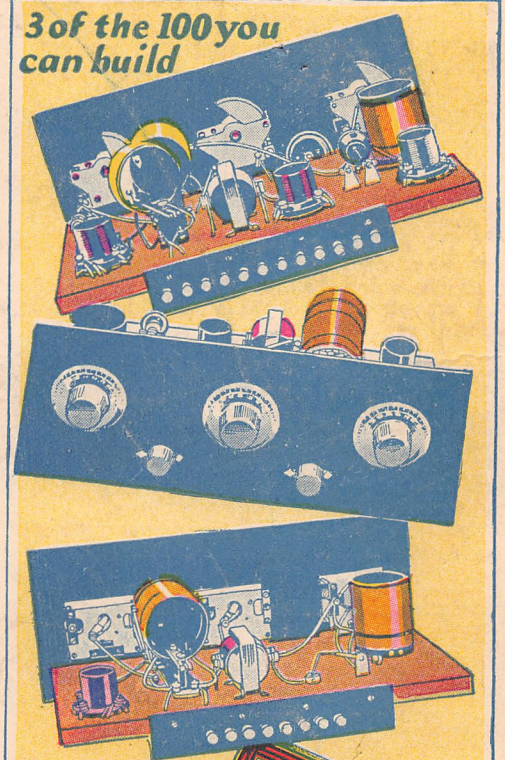
"When I enrolled I was a motorman on a trolley car. Now I have a fine, fast growing Radio business of my own. I have $2,800 in the bank and about $300 worth of Radio stock. I made it all since graduating less than six months ago."
Richard Butler,
1419 No. 17th St.,
Philadelphia, Pa.

$450 a Month

"I am operating KGFI. In addition I work in the largest and best equipped Radio shop in the southwest. I am averaging $450 per month."
Frank M. Jones,
922 Guadalupe St.,
San Angelo, Texas.

You can build 100 circuits with the six big outfits of Radio parts I give you

3 of the 100 you can build



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Dear Mr. Smith:—Send me your FREE book "Rich Rewards in Radio," giving information on the big money opportunities in Radio and your practical method of teaching with six Radio Outfits. I understand this places me under no obligation.

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